Proceedings of the

NOAA Human Dimensions of Global Change Research Program's

Principal Investigators Meeting

October 23-25, 2002

Seabrook Island, South Carolina

Foreword

For the past seven years, the NOAA Human Dimensions of Global Change Research Program (HDGCR) has been supporting research focused explicitly on human adjustment to year-to-year climate variability and the potential use of seasonal forecasts in decision-making. The NOAA program funds research projects in a number of places in the US and developing countries, across a range of sectors and resource management decisions, and at different scales of analysis. The research agenda was also significantly influenced by the National Academy of Sciences report, *Making Climate Forecasts Matter* (NRC, 1999)[1], and a solid and growing research community is now in place. After several years of fieldwork, many of the research projects had methodological developments and results ready to be discussed in a comparative framework. It was becoming apparent that similar themes were arising across projects sites and types of decision-making environments being studied. Given the progress the community has made in advancing the science and assessing stakeholder needs and decision-making processes, the time seemed right to discuss research progress and determine future programmatic priorities.

The NOAA's HDGCR Principal Investigators (PI) meeting held in South Carolina in October 2002 was the second PI meeting for this NOAA program. In designing the agenda and considering research themes and methods to be discussed, we had a much more mature program to address than at the first PI meeting in 1999 when a number of projects had just begun.

Our aim in convening this second PI meeting was to address the following questions:

- What insights has the NOAA HDGCR community uncovered over the past 3-5 years?
- What are the emerging methods, tools, and information resources useful for this field of research?
- Where should this field of research be heading?

We organized the agenda around common themes that have arisen from many of our projects as they analyze the use of climate forecasts in decision making in the US and abroad. For instance, we wanted to discuss factors impeding or encouraging the use of forecasts, experiences with methods for communicating probabilistic information, the institutional contexts for forecast applications, characterizing and mapping populations vulnerable to climate fluctuations, and methods for eliciting user needs and constraints.

The researchers participating in this meeting represented a wide range of projects in terms of geographic areas and levels and types of decision-making under study. Approximately sixty participants came from across the US and as far away as Europe, South Africa, and the Pacific Islands. Disciplines represented included anthropology,

[1] Easterling, W. and P. Stern, eds., NRC, Committee on Human Dimensions of Global Change Research, *Making Climate Forecasts Matter*, (Washington, DC: National Academy Press), 1999.

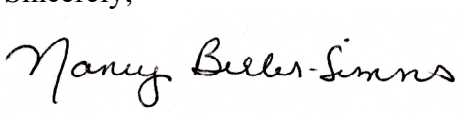
political science, sociology, economics, geography, hydrology, engineering, and climate and environmental sciences.

Both during the PI meeting and subsequently, planning and changes have been underway both at NOAA and within the federal interagency context for research on climate and global change. A focus on climate as a new cross-cutting emphasis within NOAA and the development of a Climate Change Science Program (CCSP) strategic plan initiated at high levels within President Bush's Administration have influenced the NOAA HDGCR program and its future directions. We were pleased that Susan Avery from the CCSP office and the University of Colorado was able to participate in our PI meeting and discuss with us the goals of the CCSP. These developments provided an important backdrop to our discussions in South Carolina which in turn influenced subsequent input to the CCSP strategic plan.

Through the dissemination of the following proceedings, we aim to influence the broader agenda of human adaptation to climate variability and change and to reach a broader community of those interested in studying human-environment relationships.

Finally, we would like to thank Loretta Quinn and Bree Thompson for ensuring that the meeting ran smoothly. We would also like to thank our investigators for their input and thoughtful dialogue, especially those who wrote the constructive breakout session summaries. We look forward to more opportunities in the future to engage in further fruitful discussions.

Sincerely,



Nancy Beller-Simms
Program Coordinator, Human Dimensions of Global Change Research

Caitlin Simpson
Program Director, Health and Human Dimensions Research

Table of Contents

FOREWORD iii

TABLE OF CONTENTS v

AGENDA 1

ABSTRACTS OF PLENARY PRESENTATIONS 7

HUMAN DIMENSIONS IN AN EVOLVING NOAA 7

Presenter: Jim Buizer, NOAA Office of Global Programs 7

CLIMATE CHANGE RESEARCH INITIATIVE (CCRI) UPDATE 8

Presenter: Susan Avery, University of Colorado and the Climate Change Science Program (CCSP) Office 8

EVOLUTION AND ACCOMPLISHMENTS OF NOAA/OGPR HDGCR PROGRAM 9

Presenter: Caitlin Simpson, NOAA Office of Global Programs 9

SURVEY RESULTS AND THE CURRENT NOAA/OGP HDGCR PROGRAM 11

Presenter: Nancy Beller-Simms, NOAA Office of Global Programs 11

LOCAL LEVEL FACTORS AFFECTING FORECAST USE & APPLICATION 13

Presenters: Corinne Valdivia, University of Missouri-Columbia and Emma Archer, University of Cape Town, South Africa 13

Moderator and Rapporteur: Tony Patt, Boston University and Potsdam Institute for Climate Impact Research 13

INSTITUTIONAL CONTEXT FOR FORECAST USE 16

Presenters: Maria Carmen Lemos, University of Michigan and Denise Lach, Oregon State University 16

Moderator and Rapporteur: Roberta Balstad Miller, CIESIN, Columbia University 16

EXPERIENCES WITH COMMUNICATION OF CLIMATE FORECAST INFORMATION 17

Presenters: Mike Hamnett, University of Hawaii, and Ben Orlove, University of California-Davis 17

Moderator and Rapporteur: Colin Polsky, Harvard University 17

ROLE OF FORECASTS IN THE RISK MANAGEMENT STRATEGIES OF DIFFERENT SECTORS 20

Presenters: Kirsten Dow, University of South Carolina/Stockholm Environment Institute, and Jim Mjelde, Texas A&M University 20

Moderator and Rapporteur: Michael Scott, Battelle Pacific Northwest Laboratory 20

STUMBLING BLOCKS/CONSTRAINTS TO FORECAST USE 23

Presenters: Steve Rayner, Oxford University, and John Weiner, University of Colorado at Boulder 23

Moderator and Rapporteur: Ana Iglesias, Goddard Institute for Space Studies at Columbia University and Universidad Politecnica de Madrid 23

COPING STRATEGIES USEFUL FOR SHORT TERM VARIABILITY AND LONG-TERM CHANGE 24

Presenters: Mark Meo, University of Oklahoma and Paul Kirshen, Tufts University 24

Moderator and Rapporteur: Richard Adams, Oregon State University 24

ELICITING USER NEEDS: METHODS FROM DIFFERENT DISCIPLINES 26

Chair: Roger Pulwarty, Climate Diagnostics Center, NOAA/CIRES 26

Presenters: Jere Gilles, University of Missouri-Columbia, Daniel Suman, University of Miami, Carrie Pomeroy, University of California-Santa Cruz 26

Rapporteur: Dan Hallstrom, North Carolina State University 26

ELICITING USER NEEDS: METHODS FROM DIFFERENT DISCIPLINES 27

Chair: Carla Roncoli, University of Georgia 27

Presenters: Aris Georgakakos, Georgia Institute of Technology, Bob O'Connor, National Science Foundation/Pennsylvania State University, David Brookshire, University of New Mexico 27

INTEGRATING QUANTITATIVE AND QUALITATIVE APPROACHES WITH STAKEHOLDER INTERACTIONS 28

Presenters: Kathy Galvin, Colorado State University, and Kathy Miller, National Center for Atmospheric Research. 28

Moderator and Rapporteur: Greg Carbone, University of South Carolina 28

VULNERABILITY MAPPING 31

Presenters: Roberto Sanchez-Rodriguez, University of California-Santa Cruz, and Tim Finan, University of Arizona 31

Moderator and Rapporteur: Jennifer Phillips, Bard College 31

INFORMATION SOURCES AND TOOLS 33

Climate Information Project 33

Presenter: Kelly Sponberg, NOAA/OGP 33

The HERO Collaboratory 33

Presenter: Brent Yarnal, Pennsylvania State University 33

Decision Making Software 34

Presenter: Jennifer Phillips, Bard College 34

Mapping the Climate Applications Landscape 34

Presenter: Tahl Kestin, IRI 34

Datasets available at the International Research Institute for Climate Prediction (IRI) 35

Presenter: Anji Seth, IRI 35

WHAT'S HOT & WHAT'S IMPORTANT 37

Co-Chairs and Rapporteurs: Kris Wernstedt, Resources for the Future and Bill Easterling, Pennsylvania State University 37

THE NEED FOR GREATER INTEGRATION OF HUMAN FACTORS INTO RESEARCH ON CLIMATE AND HEALTH 38

Presenter: Juli Trtanj 38

NOAA POST-DOC PROGRAM 39

FUNDING OPPORTUNITIES WITH THE NATIONAL SCIENCE FOUNDATION 40

Presenter: Bob O'Connor 40

APPENDIX A 42

List of Participants 42

APPENDIX B 48

Conference Participants and the Sector of their NOAA Research 48

APPENDIX C 49

Conference Participants, their Affiliations, and the Location of their NOAA Research 49

APPENDIX D 50

List of Projects Funded 1995–2002 50

ACRONYM LIST 55

AGENDA

Human Dimensions of Global Change Principal Investigators Meeting

Seabrook Island, South Carolina
October 23 – 25, 2002

Tuesday, October 22 ***p.m.***	
6:00 – 9:00	Dinner – *Island House Restaurant*
7:00 – 8:30	Welcome reception (with cash bar) and registration - Continuous Showing of NOAA/OGP Video: "Climate and Sustainable Development – Rio to Johannesburg and Beyond" *[Carolina Room]*
Wednesday, October 23 ***a.m.***	
	Breakfast – *Island House Restaurant* (opens at 7 a.m.)
8:00 – 9:00	Registration Desk Open *[Carolina Room]*
	Focus I: Welcome Plenary
8:30 –10:00	Plenary Session *[Carolina Room]* • Welcome – Nancy Beller-Simms and Caitlin Simpson • Human Dimensions in an Evolving NOAA– Jim Buizer • CCRI Update - Susan Avery • Evolution and Accomplishments of NOAA/OGP HDGC Program – Caitlin Simpson • Survey Results and Current NOAA/OGP HDGC Program – Nancy Beller-Simms • Discussion of Meeting Format – Caitlin Simpson and Nancy Beller-Simms
10:00 – 10:15	Break

Focus II: Cross Cutting Research Themes

10:15 – 11:15	Simultaneous Sessions • Local Level Factors Affecting Forecast Use and Application: Emma Archer, Corinne Valdivia Moderator: Tony Patt *[Cooper]* • Institutional Context for Forecast Use: Maria Carmen Lemos, Denise Lach Moderator: Roberta Balstad Miller *[Seaview]*
11:15 – 11:30	Break
11:30 - 12:30	Simultaneous Sessions • Experiences with Communication of Climate Forecast Information: Mike Hamnett, Ben Orlove Moderator: Colin Polsky *[Cooper]* • Role of Forecasts in the Risk Management Strategies of Different Sectors: Kirsten Dow, Jim Mjelde Moderator: Michael Scott *[Seaview]*
12:30 – 1:30	Lunch – *Island House Restaurant*
1:45 – 2:45	Simultaneous Sessions • Stumbling Blocks/Constraints to Forecast Use: Steve Rayner, John Weiner Moderator: Ana Iglesias *[Cooper]* • Coping Strategies Useful for Short Term Variability and Projected Long Term Change: Mark Meo, Paul Kirshen Moderator: Richard Adams *[Seaview]*
4:00 – 6:30	Sunset Dolphin-watching Cruise/Free Time – See Registration Desk for more information
7:30 – 9:00	Dinner – *Island House Restaurant*

Thursday October 24, 2002

Focus III: Methodology

Breakfast – *Island House Restaurant* (opens at 7 a.m.)

8:30 – 10:00

Eliciting User Needs and Methods from Different Disciplines – Parallel Sessions - Choose session according to interest

Session A *[Cooper]*	Session B *[Seaview]*
Roger Pulwarty (Chair)	Carla Roncoli (Chair)
Jere Gilles	Aris Georgakakos
Dan Suman	Bob O'Connor
Carrie Pomeroy	David Brookshire
Dan Hallstrom (Rapporteur)	Steve Hu (Rapporteur)

10:00 – 10:15

Break

10:15 – 11:45

Developing Decision Tools – Simultaneous Sessions

- Integrating Quantitative and Qualitative Approaches with Stakeholder Interactions: Kathy Galvin and Kathy Miller
  Moderator: Greg Carbone *[Cooper]*

- Vulnerability Mapping: Roberto Sanchez-Rodriguez and Tim Finan
  Moderator: Jennifer Phillips *[Seaview]*

12:00 – 1:30

Lunch *[Island House Restaurant]* // Poster Set-Up *[Atlantic Room]*

1:30 – 3:30

Information Sources and Tools *[Carolina Room]*

- Climate Information Project – Kelly Sponberg, NOAA/OGP
  - RANET
  - (ERS) Elemental Reporting System
  - Visualization of CRED (Center for Research on the Epidemiology of Disaster) International Database
- The Hero Project – Tools for Collaborative Human Dimensions Research - Brent Yarnal
  - Adelphi Technique Program
  - E-Notebook
- Decision Making Software – Jennifer Phillips
- IRI Datasets – Tahl Kestin and Anji Seth
  - Application Database
  - Climate Information Digest
  - ENSO Quick Look
  - ENSO Impacts Monitoring Project

3:45 – 5:00 Poster Sessions/Presentations *[Atlantic Room]*

Focus IV. Dinner and Evening Discussion

7:00 – 9:30 Enjoy a delicious dinner with colleagues. This will be followed a spirited discussion of "What's hot and what's important in HDGC." Co-chairs: Kris Wernstedt and Bill Easterling *[Terrace]*

Friday, October 25, 2002

Focus V: The Future

Breakfast – *Island House Restaurant* (opens at 7 a.m.)

8:00 – 9:00 Plenary *[Carolina Room]*

- The Need for Greater Integration of Human Factors into Research on Climate and Health – Juli Trtanj
- NOAA Post-Doc program – Emma Archer, Colin Polsky
- Funding Opportunities with the National Science Foundation – Bob O'Connor

9:10 – 10:15 Small group discussions on the NOAA/OGP/HDGC program. gaps, next steps for the program, and longer-term recommendations for NOAA and the HD community.

Participants with last names beginning with the letters:

A – M *[Cooper 1]* Moderator: Claudia Nierenberg; Rapporteur: Juniper Neill

N - Z *[Cooper 2]* Moderator: Lisa Farrow Vaughn; Rapporteur: Juli Trtanj; Rapporteur: Aurelia Micko

Break and Hotel Checkout

10:15 – 11:00 Plenary *[Carolina Room]*

- Report of small groups – session leaders
- Wrap up – Caitlin Simpson, Nancy Beller-Simms

11:00 – 12:00 Box lunches available

Summary of the Human Dimensions of Global Change Research Program - Principal Investigators' Meeting

Sixty people attended the NOAA Human Dimensions of Global Change Research (HDGCR) program's Principal Investigators (PI) meeting held October 23- 25, 2002 on Seabrook Island, South Carolina. Following is a summary of key insights gained at the meeting and suggestions made by those in attendance for the program's future direction.

Key Insights

The NOAA HDGCR researchers who attended this conference believe that they have produced a new field with common objectives and shared goals. The investigators expressed solidarity and feel that they "have made a difference along the way". Moreover, they believe that a paradigm shift has occurred in the field of human dimensions of global change research even beyond the NOAA program. For example, five years ago, global change researchers concentrated on specific climate change consequences such as the impacts of sea level rise. The field has expanded to include a focus on the improvement of climate forecast information dissemination and the betterment of the relationships between forecasters and decision makers for future planning and mitigation of disasters.

Overarching findings from their research show that:

- Many users lack experience with understanding and using climate forecast information. They often have local or indigenous systems of making forecasts. In some cases, these prepare them to use modern scientific forecasts at different spatial and temporal scales.

- Information needs vary by sector and location. For example, the PIs working in the water management field found that staffs in this sector require information across a range of scales (i.e., 7-day to 6-month forecasts). They would prefer this data in simple color maps. In the future, they will need a better understanding of institutional modeling, improved evapotranspiration tools, and snow pack forecasts.

- Long-term face-to-face relationships with users or representatives of users are key to the use and understanding of forecast information. This requires that forecasters and data disseminators go to state/local venues on a regular basis. In addition, user training is critical to climate forecast information distribution.

- Information is altered by the cultural system into which it is introduced. This is true of the cultural systems of forecast users and forecast producers.

- Many scientists use surveys to elicit stakeholders' and/or decision makers' perceptions, needs, and preferences; however, it is essential that the surveys are written and administered by survey experts so as not to bias the results. For example, the context and placement of questions can lead to bias, as can the

interpretation by non-qualified personnel. In addition, researchers need to add in-depth interviews and focus groups to strengthen the results of the survey.

- When approaching the difficult task of creating and using integrated models (e.g., crop models integrated with economic models and decision making models), it is important to trace the uncertainties of scientific information.

- Internationally, the use of and capacity to benefit from forecasts may differ from experiences in the US. For example, in some contexts/situations within developing countries food security is a priority rather than profit maximization.

- In developed countries, well-capitalized systems could potentially endure years of "missed " forecasts. In contrast, in developing countries, some farmers may not be able to survive a year if they use a "missed" forecast in planning.

Recommendations for NOAA include stabilizing the configuration and appearance of the NOAA web site for CPC outlooks as frequent changes to the site layout cause confusion. They also recommended that forecasters work with private weather and climate service providers as they often have their finger on the pulse of the needs of users.

Future Directions

The PIs made a number of recommendations for future directions for NOAA/OGP HDGCR funding. Among their recommendations were to:

- Improve our understanding of climate variability in a societal context beyond forecasts. This would include analyzing how society copes with year-to-year variability, measuring adaptive capacity (specifically resilience and vulnerability), understanding the ethical and equity dimensions of disseminating scientific information, and developing a suite of response options and/or tools.

- Focus first on how people manage resources; avoid pushing seasonal forecasts. Using climate variability as a way of studying resource management could provide a better understanding of the broader issues of communicating information, decision making under uncertainty, sustainable use of resources, and adaptation to climate change (e.g., How do institutions respond to stresses in the system (i.e., growth demands) in the context of climate variability and change?).

- Include studies on the linkages to disaster mitigation (e.g., emergency planning at local levels).

- Forge better linkages between local and regional scales.

- Incorporate attention to local languages and cultures in the preparation of forecasts and other climate products. A good deal of misunderstanding of forecasts comes from poor translations from English and other major language groups into local languages.

Abstracts of Plenary Presentations

October 23, 2002
8:30 – 10:00 a.m.

Human Dimensions in an Evolving NOAA

Presenter: Jim Buizer, NOAA Office of Global Programs

Within NOAA's Office of Global Programs is a multidisciplinary team of federal government employees and contractors who comprise the Climate and Societal Interactions (CSI) team. CSI staff stimulate and support innovative research on climate-human interactions and the use of this insight for the development and prototype implementation of decision support tools. Much of the research is performed at universities and federal labs. Funding is available through a combination of traditional grants programs and participatory research and applications activities focused on key socioeconomic issues. Program managers encourage problem-oriented, solution-driven, and place-specific approaches to climate-society research that lead to the integration of disciplines, creation of institutional partnerships, and active relationships with stakeholders.

The team is divided into three core programs and activities: Health and Human Dimensions Research; Integrative Science, Assessments, and Communication; and Environment, Science and Development (ESD). The programs aim to advance current knowledge and to foster the use of science in practice. Team members work closely together to achieve this goal by drawing on process studies and modeling from the Health and Human Dimensions Research program, assessments research performed by the CSI Regional Integrated Sciences and Assessment Program, and the transfer of science and technology to society through the ESD program. See Figure 1.

The primary objectives of CSI are to support:

- Broader and improved methods, processes, participation, data, and documentation leading to identification of challenges most central to balancing human quality of life and protection of the environment.
- A solid scientific foundation and mechanisms for understanding the complex physical, biological, and social pathways through which climate affects human affairs that are developed and articulated in ways accessible to the public.
- Expanded options at a range of temporal and spatial scales for addressing identified challenges in ways that bring into balance human quality of life and preservation of the natural system.

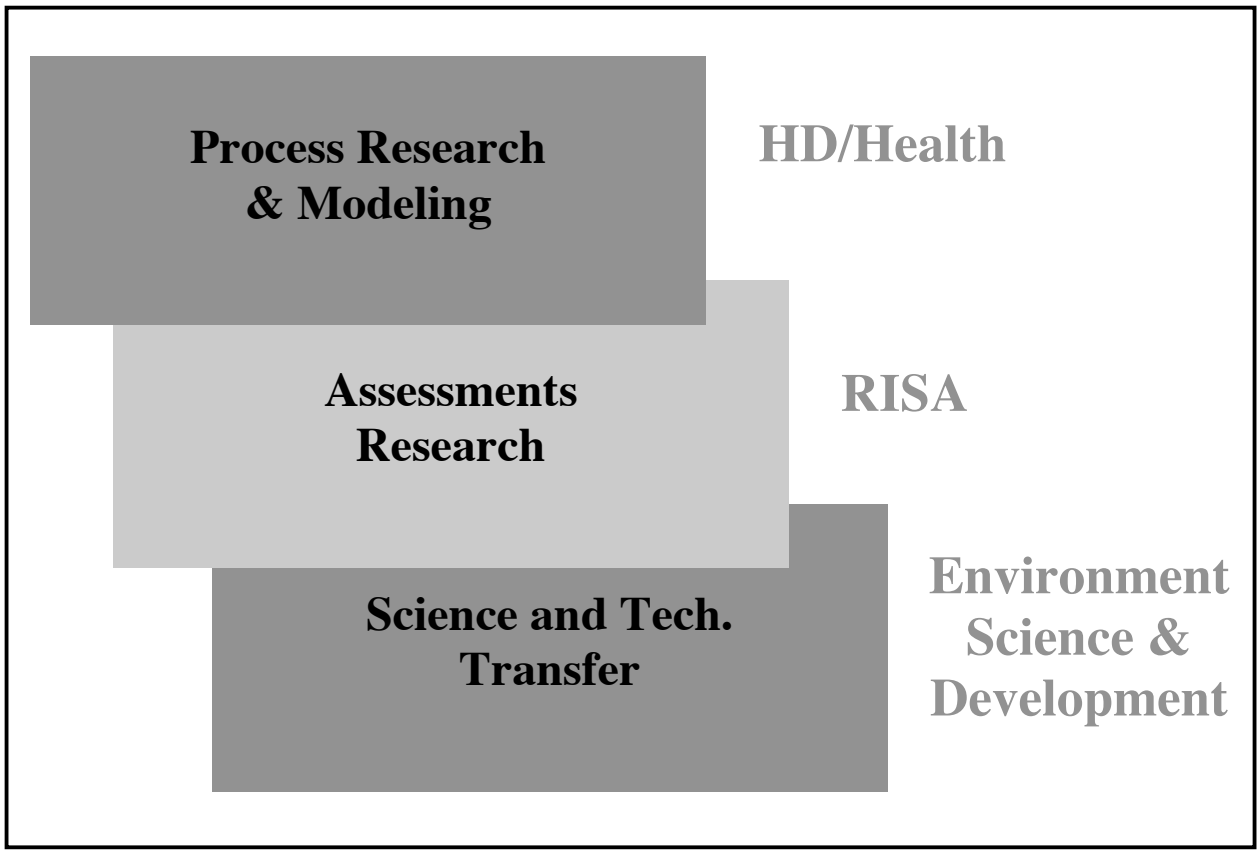


Figure 1. CSI Program Framework

- A managed investment in education, training and other forms of scientific and technical institutional capacity building essential for realizing the benefits of scientific research.
- A well-managed program of sponsored research and related activities with established mechanisms for evaluation that highlight opportunities for innovative management options in a world requiring higher order connectivity between scholarship and action.

Climate Change Research Initiative (CCRI) Update

Presenter: Susan Avery, University of Colorado and the Climate Change Science Program (CCSP) Office

Susan Avery discussed the process in place for developing a strategic plan for the Climate Change Science Program (CCSP) that encompasses the Climate Change Research Initiative (CCRI) and the US Global Change Research Program (USGCRP). The call for a plan was initiated at high levels within President Bush's Administration,

and for the past year, the plan has been an important focus of the federal agencies' global change research programs.

Susan gave an overview of the interagency process for developing the strategic plan including the importance of broad scientific and public input into the plan. She highlighted the need for involvement of the human dimensions research community in formulating research directions and specifically asked for the participation of the NOAA HDGCR community at the US Climate Change Science Program: Planning Workshop for Scientists and Stakeholders on December 3-5, 2002 in Washington, DC. The December workshop was a public forum for discussing a draft of the strategic plan, critical research gaps in the science of climate variability and change and their interaction with society, and possible future directions for the CCSP.

More information about the Climate Change Science Program, including the strategic plan and information about the December workshop, can be found at http://www.climatescience.gov/.

Evolution and Accomplishments of NOAA/OGPR HDGCR Program

Presenter: Caitlin Simpson, NOAA Office of Global Programs

Caitlin Simpson gave an overview of what has been covered by the NOAA HDGCR program in recent years. The presentation included a description of program objectives, the topics and geographic areas covered by research projects thus far, methods used within the projects, and how human dimensions science is connecting directly with policy and decision making. She also discussed crosscutting themes that have arisen out of the research focused on the use of information and how these themes provided an organizational framework for this meeting.

The goal of the NOAA Human Dimensions of Global Change Research (HDGCR) program is to advance our understanding of human response to and planning for climate variability in the context of improved scientific information.

Program objectives include the following:

- Analyze how and to what extent society is utilizing climate forecasts and the reasons in many cases society is not yet using the information;
- Provide feedback to influence the production and dissemination of climate forecast information;
- Understand the unintended consequences (indirect effects) of producing and disseminating climate forecasts;
- Demonstrate potential value of scientific information;
- Advance our state of knowledge of how society copes with climate and influence scientific agenda on adaptation to climate change;
- Provide input to NOAA's research and services missions and the broader research agenda of the Administration's Climate Change Science Plan (CCSP).

The topics and geographic areas covered by the program have been diverse and wide-ranging. Projects have focused on agriculture, fisheries, water management, rangeland management, drought policies, disease outbreaks, forest management, and energy issues, with the largest number of projects investigating farming issues. Research has been conducted in the US and abroad. See Figure 2.

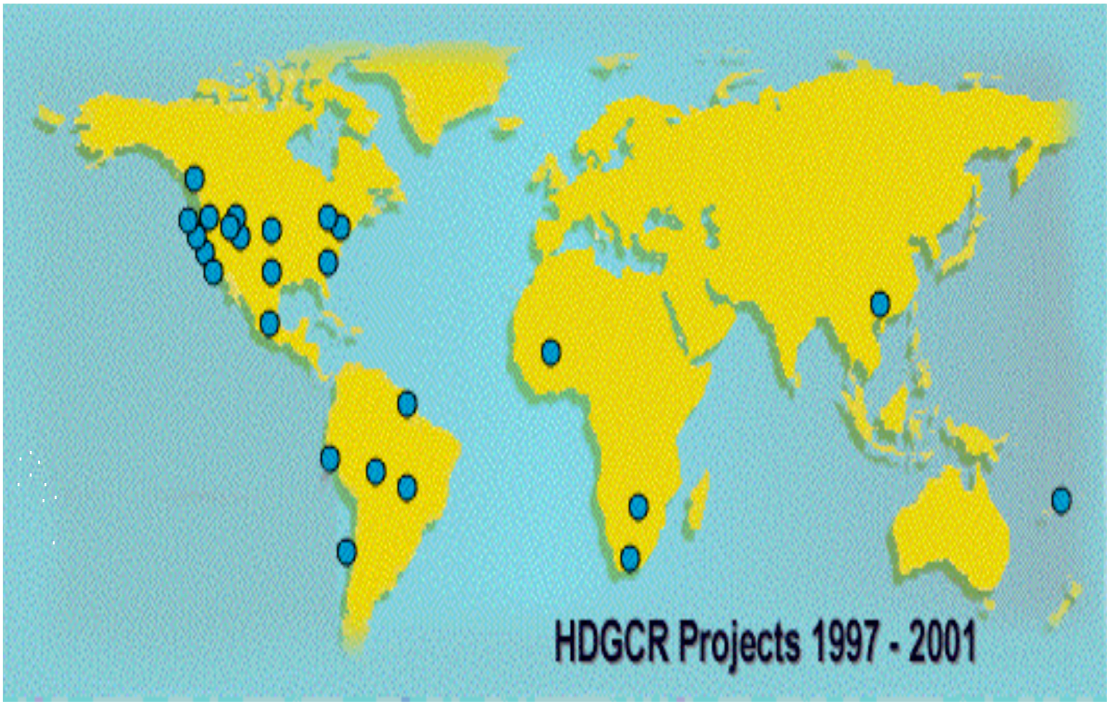


Figure 2. NOAA/HDGCR Projects 1997–2001.

The main methodological approaches tend to fall into the following categories:

1) Simulation modeling of potential value of information, possible response options and economic impacts;
2) Surveys, focus groups, and/or in-depth interviews to illuminate constraints and incentives to the use of forecasts, and actual or potential use of forecasts;
3) Combination of qualitative and quantitative approaches (e.g., combinations of 1 and 2).

More specific methods include the following: human ecology modeling; ethnographic surveys and fieldwork; economic game theoretic modeling; bio-economic modeling; vulnerability mapping; and decision modeling/mapping.

Not only do HDGCR investigators study the decision-making context and how it is affected by climate, HDGCR science is enhancing decision and policy making in many cases. For instance, in Northeast Brazil, state officials plan to use vulnerability mapping for improved drought planning. In Uganda, techniques are being developed for communicating scientific information in local languages and through local expressions

via radio for farmers. In the Colorado River Basin, climate information has been used within the adaptive management framework for water management within the basin.

Finally, crosscutting themes common to many of the projects and findings are emerging. Projects have identified both constraints to the use of forecasts as well as potential value. Local factors, including gender, indigenous knowledge and forecasting, access to resources and markets, and social networks all play a role in the uptake of forecast information. Several projects have investigated institutional rigidities and flexibility and the role of public policy in relation to adopting new scientific information. Innovative mechanisms, such as adaptive management or water markets, could offer some additional institutional flexibility. The role of intermediaries, such as extension agents, private companies, and the media, may play a larger role in the dissemination and communication of forecast information in the future. Coping strategies have been identified and vulnerability analyses are underway. Moreover, understanding perceptions of risk by decision makers and the communication of uncertain scientific information to decision makers are important components for reaching many end-users. Finally, managing transboundary resources (e.g., water or fish) adds complexity to issues of utilizing improved climate information.

Survey Results and the Current NOAA/OGP HDGCR Program

Presenter: Nancy Beller-Simms, NOAA Office of Global Programs

Being completely new to the program, I conducted a survey of past and present Principal Investigators (PIs) of the NOAA HDGCR Program in October 2001. The results of four key questions are presented below. Fifteen of the approximately twenty-five PIs funded over the last five years responded.

Question 1. How did this project influence your overall research?

The primary response to this question was that working on a project through the HDGCR program resulted in the first time assemblage of representatives from a variety of disciplines. After the initial project with NOAA/OGP, PIs reported that there was further interaction among researchers and decision makers. The work that the PIs performed increased their breadth of knowledge and spiked new areas of interest. In addition, it inspired PIs to pursue futher research on climate change issues with other funding sources. The work done for this program also developed models and trained new researchers.

Question 2. What was the principal contribution of your work to the study of human dimensions of global change more broadly?

The answer most often given by the PIs in response to this question was that their contribution to the study of human dimensions demonstrated the economic value of forecasting. They also reported that their work identified specific forecasting needs. PIs

reported that their work also recognized alternative management and mitigation strategies, documented understanding of the complexities of vulnerability and adaptation, and established potential impacts of unanticipated climate regime shifts.

Question 3. Given your knowledge of our (NOAA/OGP/CSI) accomplishments over the years, which areas of study do you foresee will become more important in the future?

The PIs felt that studies in the following areas would become more important in the future (in order of most responses): working with the science community on products, addressing adaptation, understanding vulnerability/risk, taking a different approach, targeting specific fields, and encouraging interagency work.

Question 4. Do you feel that there are any areas that we have not highlighted in the past that will be important in the future? Is there any one or a set of areas towards which you believe we should focus our funding in the near future? Distant future?

The most cited areas that the PIs felt would be important in the future were to: enhance the study of communication, explore vulnerability issues, incorporate studies from other regions, incorporate more social science studies, and include other individual topics.

SUMMARIES OF BREAKOUT SESSIONS

October 23, 2002
10:15 – 11:15

Local Level Factors Affecting Forecast Use and Application

Presenters: Corinne Valdivia, University of Missouri-Columbia and Emma Archer, University of Cape Town, South Africa
Moderator and Rapporteur: Tony Patt, Boston University and Potsdam Institute for Climate Impact Research

Corinne Valdivia presented research that she conducted in the Andean region of Bolivia and Peru, a region that is susceptible to droughts, frosts, and floods at elevations between 3,000 and 3,900 meters. The two issues most relevant to this session topic and the Andean region include diversity of livelihood strategies and access to information.

- Diversity Of Livelihood Strategies. The portfolios of economic activities in the Andes are very diverse. Many families have access to urban or peri-urban markets, but their level of participation as consumers or suppliers varies. Portfolios of resources vary within and between rural communities, in terms of access to land, soil types, varieties of animals owned, and off-farm employment opportunities. Most households in the Altiplano communities where the research took place produce many varieties of potatoes for consumption, seed, and sales. These families also transform potatoes into *chuño* (freeze-dried potatoes that can be kept for many years), which is consumed, sold and/or stored depending on the type of production year. Households with a high level of diversity in their economic portfolio engage in dairy farming, food and forage crop production, and off-farm activities. Households with dairy cattle are wealthy and can borrow when there is a drought because milk sales act as collateral for credit. As a result, they are able to smooth consumption over time. This group is in a better position to use forecast information because they stand a better chance of risking a loss. At the same time they are less interested in climate forecast information because the economic portfolio is less sensitive to climate variability, and they have risk insurance options. Although this group grows potatoes, credit is available to cover losses. Households that are less diversified are focusing on food crops, especially potato production, which are more sensitive to climate. They are more likely to use local climate forecast indicators because of fewer insurance strategies and coping mechanisms. Chuño for these households is an important buffer against a bad year.

- Access to Information. Valdivia and her colleagues found that some farmers manage local knowledge forecast indicators for the production of crops. Although many networks exist, their nature varies depending on the type of information flow. Those relying heavily on crops for income are the ones who participate in the local knowledge forecast network, which is related to the potato producers. They also

found that farmers who sell in the market are interested in climate events happening in other regions of the country. In Peru, for example, farmers were interested in climate events in other regions as they relate to production and prices for the commodities they sell. In addition, the researchers found that access to information through radio does not imply use of information for decisions. Farmers indicated that locality is an important factor in assessing how appropriate the forecasts are.

Emma Archer presented on her research in the Limpopo Province of South Africa. She examines the sensitivity to drought of farmers who grow crops both for subsistence and to sell in markets. In her presentation she focused on two problematic themes in forecast applications, and two ways to improve the process.

- Problematic Themes. Archer found that the location of the decision-makers within their environment is a key factor in affecting their decisions on forecast use and application. Location includes position within the household or the person's relationship to the head of the household. She found that within the community, many groups are potentially excluded from community decision-making. Age, gender, and language matter in both contexts. Another factor that influences forecast use and application in this region is variation in key resource endowments. These occur intra- and inter-community, and take the form of differences in land, credit, off-farm income, water, and labor skills.

- How to Proceed. Archer proposed two ways to improve the process. First, sophisticate the notion of the end user, including strategies to integrate local forecasting methods. Second, work further up the forecast chain: pay attention to intermediaries and institutional capacity. See Figure 3.

Discussion continued as to what local level factors were most important. Valdivia noted that in the Andes farmers respond to markets, and in a way this could increase their vulnerability, as efforts to increase income may reduce their diversity and with it their buffering capacity. Archer noted that many of the factors affecting local forecast communication are not rooted in the locale itself, but within the rigidity of the forecasting and/or boundary organization. Thus, institutional learning becomes important.

Discussion then touched on the following themes:

• *Correlations between resources and involvement in local networks*: in Africa, the correlation coefficient is positive. In the Andes, the networks in which people participate differ depending on kinship and the productive activities in which families are engaged.

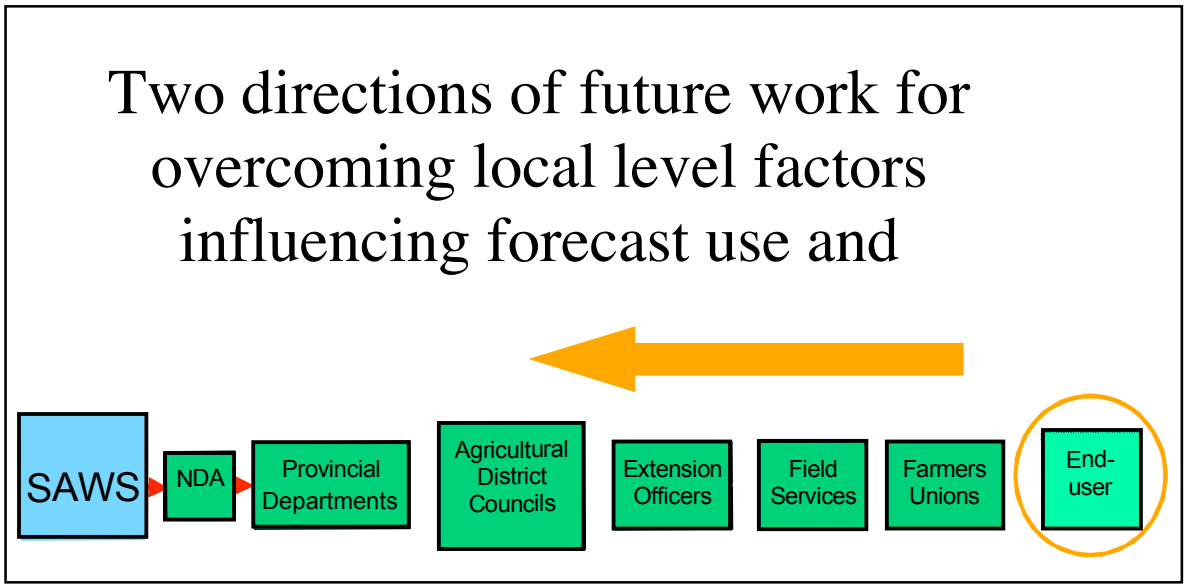


Figure 3. The Forecast Chain

• *Sources of vulnerability to famine*: In the Andes there is a high correlation between poverty and climate sensitivity, exacerbating vulnerability, especially in terms of chronic malnutrition and decrease in spending in human capital (e.g., schooling for children). This happens because low income farmers mostly are engaging in crops, which are highly covariant with climate variability, as these are lost to droughts or floods. As a result assets (livestock) are sold to cope with the event. We are finding that through time these groups of farmers (resource poor and the elderly) have lost the diversity of their portfolios, are mostly engaged in crop production, and therefore exposed to the effects of climate. In the Southern African Development Community (SADC) region, limited resources may both increase sensitivity to climate and may interact with climate sensitivity to increase vulnerability of, for example, the household unit. When working with people who are not the poorest of the poor, it is still worthwhile to understand their vulnerability since vulnerability may be a relative concept.

• *Role of religion*: In the Andes religion networks are in flux with more Protestants arriving. In Africa, one may examine the church as a potential network for women, though the church may be uncomfortable with reference to local climate indicators.

• *Notion of the end user*: On the one hand, we need to identify who exactly uses the information and how best to reach him/her. On the other hand, the idea of focusing only on an *end* user may be problematic, hence the point above about building capacity amongst intermediaries such as local institutions.

Institutional Context for Forecast Use

Presenters: Maria Carmen Lemos, University of Michigan and Denise Lach, Oregon State University
Moderator and Rapporteur: Roberta Balstad Miller, CIESIN, Columbia University

The two presentations in this session both emphasized how institutional contexts affect the ways in which climate forecasts are interpreted and used by managers and policy makers in local governments. Maria Carmen Lemos discussed research that she and Tim Finan of the University of Arizona performed on decision making related to agriculture and drought relief in the state of Ceara in northeastern Brazil, and Denise Lach reported on the role of climate forecasts in managing institutional uncertainty by water resources agencies at three sites in the United States.

Lemos defined "institutions" as regularities of human action and behavior in situations structured by generally accepted rules. Her research examined how these institutions govern behavior and relate to new information from climate forecasts. She reported that climate forecasts were potentially valuable for applications in the timing of planting (*Hora de Plantar*), in water management, and in civil responses to drought and other emergency situations. Noting that in the abstract, the model of technocratic decision-making appears to be authoritative, value free, and consequently insulated from politics, she also found that in practice, technocratic interventions appear to insulate decision makers against the consequences of their actions. They also can be used to claim disinterested policymaking for what are in essence political decisions. She gave two examples of how forecasts were used for political ends in the Brazilian state of Ceara, concluding that climate forecasts are used to further multiple agendas, including some that are significantly different from those for whom the forecasts were initially intended. In the worst-case scenario, she found that the science-generated information (forecasts) was discredited. Her report emphasized the importance of institutional contexts, including political, environmental, economic, and cultural elements, in determining the use of science-generated policy tools.

Lach reported on research conducted by herself, Steve Rayner of the Economic and Social Research Council in the UK, and Helen Ingram of the University of California at Irvine. Based on over 120 semi-structured interviews with managers, technicians, and decision makers in the Pacific Northwest, Southern California, and the Potomac River Basin/Chesapeake Bay areas, she concluded that forecast information is most likely to be introduced through existing institutional structures and routines by internal technical staff. She reported on a series of approaches to using forecasts in various water resource agencies that ranged from infrastructure intensive and even redundant responses to a dependence on scientific input to contingent adaptation, in which water management strategies are based on intensive social interaction. At times, she found that the application of climate forecasts was limited because of users' uncertainty about the reliability of the forecasts and to the lack of spatial specificity in forecasts. See Figure 4.

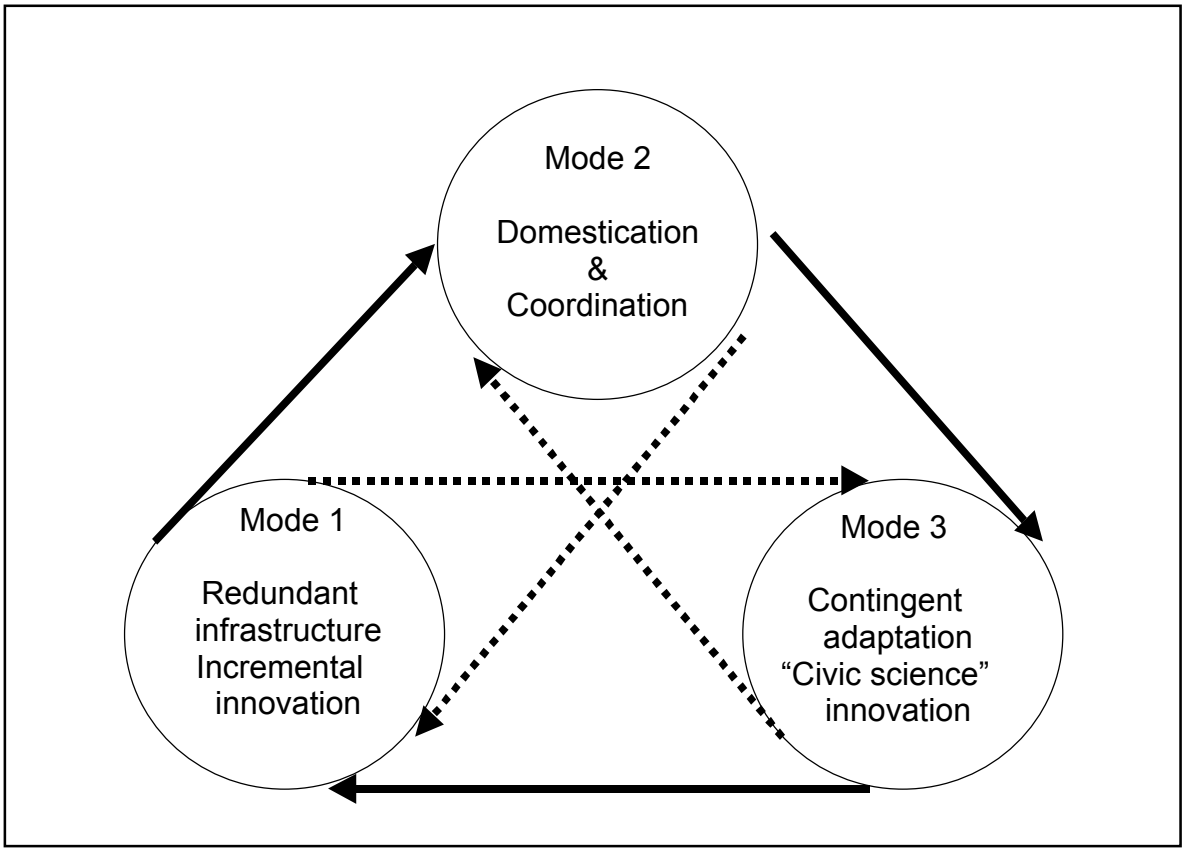


Figure 4. Spiral of transformation in the U.S. Water Resources Sector.

October 23, 2002
11:30 – 12:30

Experiences with Communication of Climate Forecast Information

Presenters: Mike Hamnett, University of Hawaii, and Ben Orlove, University of California-Davis
Moderator and Rapporteur: Colin Polsky, Harvard University

Mike Hamnett spoke on behalf of the health and fisheries projects associated with the Pacific ENSO Applications Center (PEAC) based in Hawaii and covering the Pacific Islands. This presentation provided valuable lessons learned over a series of projects designed to improve social welfare by disseminating ENSO forecasts to governments and other agencies in the US-affiliated Pacific Islands. For the first two years of PEAC operation, staff held workshops for potential users of seasonal to inter-annual climate forecasts to provide some basic information about ENSO cycles and local impacts and to identify the kinds of climate information that would be useful to a wide range of users.

Since PEAC was established in 1994, a crucial dimension to their research that emerged is the notion of "predictive skill." For PEAC predictive skill is superb during El Niño years for many of the areas it serves, particularly during wet seasons. Whereas, the skill level is poor for non-El Niño years. Thus, PEAC staff found it crucial to maintain communication links with potential end-users even during non-El Niño years to keep end-users abreast of ongoing work. During its first three years of operation, PEAC developed enough trust and credibility with end-users that stakeholders in the region used their information effectively during the 1997-98 El Niño event. Most of the adaptive actions undertaken during this event were of the "no regrets" type (e.g., infrastructure-related activities that deliver a positive return on investment even in the absence of El Niño). See Figure 5.

Figure 5. Billboard calling for water conservation in Pohnpei during the 1997-98 El Nino.

The second presenter of this session, Ben Orlove, spoke on behalf of a project, "Improving Climate Forecast Communications for Farm Management in Uganda," that he and Jennifer Phillips of Bard College began in August 2000. This presentation reported on work testing the hypothesis that disseminating Seasonal Climate Forecasts

(SCFs) in local languages, and directly to end-users, is more effective than providing such information using an intermediary. The researchers use radio broadcasts to communicate directly to farmers rather than the intermediary of district agricultural offices. Prior to using the radio, the researchers engaged potential end-users in surveys and listening groups to identify some of the salient climate- and perception-related issues. One important lesson is that because the government agricultural offices enjoy legitimacy and the cachet of officially-sanctioned information with the public, every effort must be made to maintain that legitimacy when using new communication media. The issue of language and meaning was also found to be of primary importance. Often the language used by the government agencies is different from the language used by the farmers at the local level – e.g., Luganda. A detailed knowledge of the local culture and language can also help researchers turn the complex issue of probabilities, so important for the effective use of SCFs, from a possible stumbling block into an opportunity for progress. For example, the local language in one study site has a term – *obuboneero* – which implies the notion of predictive uncertainty.

One issue of concern to the audience was the concept of trust. Especially when doing such research in cultures non-native to the researchers, a solid understanding of local cultures and languages should require an enormous amount of time, which is a luxury many researchers do not have. By extension, one audience member suggested that trust, which can only be developed after a considerable time investment, is likely to disappear as soon as the researchers complete the research project. The speakers responded that if such a research project is properly carried out then the networks (social capital) should outlive the research project and the associated positive benefits should continue on their own. This approach leverages not only traditional (e.g., tribal networks) but also modern forms of networks (e.g., journalists). Even on an individual level, the project is successful (and therefore likely to produce results that outlive the project) if the farmers become more critical users of SCFs, which is a skill that should outlive the life of the research project. In Uganda, such programmatic approaches have proven successful in lowering rates of HIV infection.

In addition to trust, ethics was another concern voiced by the audience. One audience member relayed an experience where SCFs were being used by government agencies out of context to explain droughts and associated social effects when the true cause of the effects was associated with failed government policies. However, such risks should not discourage research on improving the communication of SCFs. Finally, an audience member brought up the question of future research directions. It was proposed that future research should examine the thresholds beyond which additional research (on communication dynamics related to SCFs) delivers diminishing returns.

Role of Forecasts in the Risk Management Strategies of Different Sectors

Presenters: Kirsten Dow, University of South Carolina/Stockholm Environment Institute, and Jim Mjelde, Texas A&M University
Moderator and Rapporteur: Michael Scott, Battelle Pacific Northwest Laboratory

The session featured two presentations, one on risk management as it relates to using seasonal climate forecasts, and one with specific findings from a study of community water systems that illustrated some of these issues.

Different groups/stakeholders have different views of what constitutes risk. Context, perception of risk, and controllability of risk clearly matter. For example, despite the fact that the best science demonstrates that nuclear power plants are less risky than driving automobiles, many individuals who drive cars oppose nuclear power plants on safety grounds. In addition, the type of decision influences perception of risk. Risk associated with dangerous situations is perceived and evaluated differently than monetary risk. Also, similar risks are not viewed consistently. As an example, some states in their traffic safety rules require seatbelts but do not require the use of motorcycle and bicycle helmets.

The risk-reward or risk-benefit trade-off is important. Expected monetary rewards are balanced against the variability of outcome and the possibility of ruin. The risk of automobile fatalities can be reduced to zero by foregoing the benefits of automobile travel. Hurricanes are destructive; at the same time, they are sometimes needed to fill water supply reservoirs.

Along with the perception of risk, the decision makers' objective(s) and available risk management tools determine the importance of climate variability in a management scenario. For example, an individual concerned only with expected net return would not be concerned with the variability of outcomes. Once an individual is moved to a maximum utility framework, risk aversion comes into play.

However, risk aversion may mean that probabilistic information such as climate forecasts may not be used. One reason is the avoidance of 'gambler's ruin,' where the positive expected outcome can never be gained if the individual goes "bust' in a single year (this underlies some of the conservatism and risk aversion of subsistence farmers, where gambler's ruin can be fatal.) The availability of insurance also decreases the value of climate information to individuals such as farmers, who rather than changing their behavior to incorporate climate information can simply purchase crop insurance against adverse outcomes. (The crop insurers might still find the information valuable in setting premiums, and the farmers in guiding the insurance purchase decisions.) Because of their larger scale, corporations have access to reinsurance, hedging, futures, and derivatives as coping/mitigation mechanisms. At the societal level, additional risk is offset by programs such as disaster relief, risk-minimization information programs, and overbuilding of some

infrastructure as they provide additional means to reduce the impact of climate variability and the importance of paying close attention to it.

Managing enterprises in response to climate forecasts involves managing for shifted probability density functions for a small set of weather variables and corresponding to this, shifted probability density function for net returns. But when El Niño and other years in Texas are compared for precipitation, for example, there is such a substantial overlap in the probability density functions of seasonal precipitation that it would not be wise economically to "bet the farm" on the slight shift in probabilities. With Washington State dryland wheat, an evaluation of 80 weather years showed that the expected value of managing planting date and nitrogen supplies in accordance with ENSO seasonal forecasts would have a positive expected value.

However, in some individual years, the returns were quite negative (some possibly leading to bankruptcy). So ironically, managing to incorporate risk may lead to higher mean returns at the cost of greater economic volatility. See Figure 6.

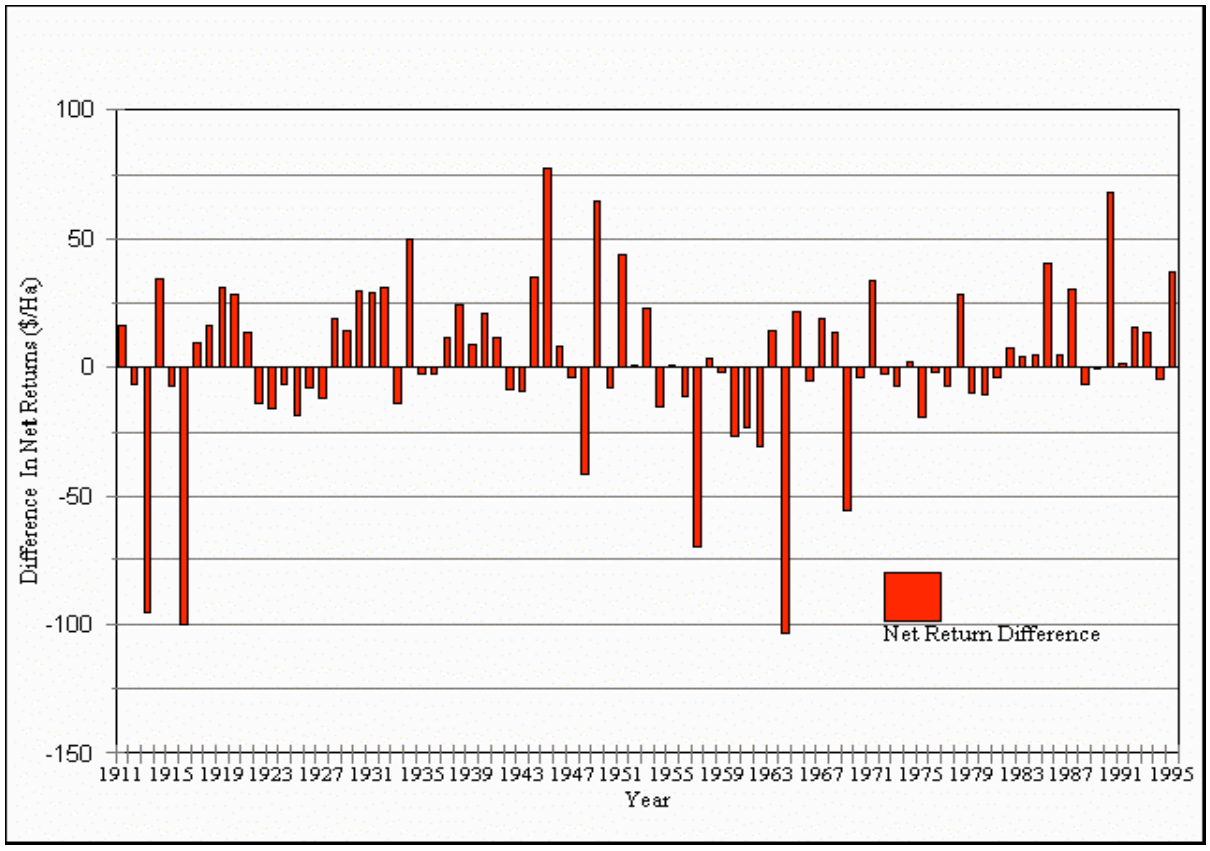


Figure 6. Annual differences in net returns between the use of ENSO-based climate forecasts and climatological information for winter wheat production in the State of Washington.

So why/how do decision makers make use of climate forecasts? In a comparative study of small community water systems (CWSs) in South Carolina and in the Susquehanna River basin of Pennsylvania, some of these factors were revealed. In general, among the ten possible uses, the heaviest uses for weather forecasts and climate (up to one year) were in the areas of scheduling personnel, maintenance, and water quality testing (this involved both 5-day type weather forecasts and longer seasonal outlooks). They also used forecasts to maintain inventory, argue for extending services and purchasing new equipment, and planning backup storage. It is important to realize that they used the forecasts in an anticipatory way for business economic improvement or advantage. In focus groups, it was clear that the value of forecasts was in improving system economic performance or reliability of water supplies, not in guiding decisions that might risk water supply reliability. Water shortages or restrictions are regarded as such unacceptable outcomes that water systems employ considerable redundant measures to avoid them.

What affects the CWS use of weather and climate forecasts when they are used? Based on regression models of survey results, systems with surface water as their source are more climate sensitive, and therefore, more likely to use climate information to improve management. Systems which were concerned with either drought risk or flood risk were significantly more likely to use weather and climate forecasts. Surprisingly, trust in the forecast or its accuracy was not a factor. That is, the CWSs that "trusted" weather and climate forecasts were no more likely to employ them than the systems that did not. In addition, there was no difference in CWS use of forecasts between South Carolina (where the El Niño signal is stronger) and the Susqehanna (where it is somewhat less so). This result would seem to indicate that for the relatively low-risk activities where weather and climate forecasts are currently used, the potential risk to water supply is of greater concern than the faith in the forecasts. This begs the question of whether more accurate forecasts would be demanded if users were willing to use the forecasts in situations that might increase the risks to their central goals.

In the ensuing discussion, one useful comment was that it is important to note that the mechanisms available to translate/use the forecasts can be as or more important than the information itself. Not used properly, using climate information to manage can increase risk. On the other hand, there are circumstances where behaving as if climate were not variable is the more risky course. In addition, increasing the amount of information does not provide a monotonic reduction in risk.

October 23, 2002
1:45 – 2:45

Stumbling Blocks/Constraints to Forecast Use

Presenters: Steve Rayner, Oxford University, and John Weiner, University of Colorado at Boulder
Moderator and Rapporteur: Ana Iglesias, Goddard Institute for Space Studies at Columbia University and Universidad Politecnica de Madrid

The presentation of Steve Rayner centered on a critique to the idea that "information can be treated as a flow of water (the hydraulic model)". Using this idea, the constraints to forecast use are simple obstacles to the flow of water, so the task for using information becomes removing the barriers to the flow of water (technological determinism).

Rayner outlined the main problems with this idea:

(a) Information is treated as one-way flow from source to consumption.
(b) From the supply side, the hydraulic model does not consider the value of information or the delivery mechanism. These issues are essential since information is highly contextualized.
(c) Issues from the demand side of the hydraulic model imply that the recipients have to have the ability to respond to the information.

Rayner concluded that this is an incomplete way of thinking about information because it considers information as an "asset", ignoring that "meaning and motivation" are also important components of information, and failing to consider what is fair, ethical, or esthetically acceptable.

John Weiner used the Arkansas Valley as a case study to address this session's focus. The case study illustrates the information needed by water managers in the Arkansas Valley. Water managers were interviewed in relation to their current use of information. The interviews were not done in the context of the 'hydraulic model" because: (a) they did not force a unique source of information; and (b) they allowed for water managers to interpret the information using their own experience.

The water managers had extensive "shopping lists" of requested information. They are subject to pressure to transfer water in drought years and a possible solution is the creation of a "water bank" that would greatly benefit from the use of information. The interaction of the water managers with the project team suggests the usefulness of Rayner's critique.

Weiner described the success that the project had in removing constraints to forecast use, but discussed that the efforts were insufficient. The constraints had been removed at the institutional level (State Agencies), but have not been removed at the social and cultural

level and at the non-state institutional level. The reason for the failure to remove the barriers in these later cases is that the "meaning and motivation" issues related to water transfers affect the applications and understanding of weather and climate information. For example, the reasons for selling water for some people are the same as the reasons for not selling water for another group of people. In addition, the political issues are complex.

After the presentations, there was a discussion of the proposed hydraulic model. Participants in the discussion provided many reasons for moving away from this model and pointed out that this process was already ongoing. In addition, several participants provided papers and guidelines describing methodologies related to eliminating constraints to forecast use.

The topic of "How to increase the body of knowledge" was introduced in the general discussion. The question is how to create a knowledge production system that is useful. Participants outlined several ideas: (a) To provide knowledge that is published, peer-reviewed, and time-tested; (b) To provide lessons; (c) To structure a dialog between social scientists and users; (d) To consider more explicitly the scale and the specificity of the sectors; and (e) To explore the possibility of carrying out ethnographic studies.

Coping Strategies Useful for Short Term Variability and Long-Term Change

Presenters: Mark Meo, University of Oklahoma and Paul Kirshen, Tufts University
Moderator and Rapporteur: Richard Adams, Oregon State University

The topic of this session dealt with coping in the near and the long terms. To explore this topic and to motivate discussion, the presenters provided brief overviews of recent or on-going studies that address various coping strategies in a range of settings. Mark Meo discussed the Oklahoma experience concerning use of the MESONET weather and soil monitoring system to plan for drought and associated fire danger. The Oklahoma study offers several insights about the coping process. First, the "hydro-illogical" cycle (a cycle Meo characterized as displaying sporadic interests in drought with no systematic planning) was broken in part because the Oklahoma Climate Survey (OCS) developed the MESONET monitoring system with Oklahoma State University and the University of Oklahoma. It helped to foster a statewide constituency that proved critical to continued financial support of the MESONET. Second, the implementation of the Fire Danger Model using MESONET and related internet-based analyses required recognition by the OCS that a series of tech-transfer workshops would be needed for the rural and urban community of stakeholders to access and effectively use the weather and climate information provided by the system. This education process, while not conceived as a strategy for drought response, was a significant "coping" and "adaptation" step since it built competency among the target users, and facilitated an attitudinal shift from a reactive posture to a more proactive posture.

Paul Kirshen's presentation focused on two examples of the use of short-term strategies and the potential to adapt to long-term climate change. The first case involved the municipal water supply system for the Boston metropolitan area. The managers of this system have developed strategies to deal with short-term variability in water supply, as well as strategies to manage short-term demand for water. This system has the potential to adapt to longer-term climate change, given the capital-intensive nature of the system, including two reservoirs for storage. However, Kirshen noted that even in such a highly capitalized system, there is a need to account for a range of potential changes in institutional and socio-economic factors that will affect adaptations in the end. These include changes in incomes and society's preferences (towards, for example, protection of ecological systems and the values associated with them) that may limit some types of adaptation.

Kirshen's second example involved the African country of Burkina Faso, a relatively poor country with a highly variable climate. In this country, farmers have had to adapt to drought. A range of current adaptation strategies exists, such as changing crops, acres planted, selling of livestock, etc. These may have potential in addressing long-term climate change in such a setting, given that the long-term trend in drought frequency may continue. However, results from this study also indicate that the existence of planning institutions and appropriate market signals may be more important in terms of dealing with long-term climate change than continued reliance on some of the short-term options.

Substantial audience discussion focused on the contrasts between "coping" by using weather forecasts in highly capitalized systems (like the Oklahoma and Boston cases) and those in subsistence agriculture, where farmers tend to be risk averse and where a "wrong" forecast can have disastrous consequences. It was also noted that in some settings, the more numerous are coping strategies, the more resilient is the sector and hence the less valuable are the forecasts. In the context of subsistence agriculture, several in the audience noted that continued degradation in Africa was reducing the effectiveness of available coping strategies and increasing the costs of those adaptations. One member of the audience observed that how a system adapts to longer term change may be the result of iterative changes that sequentially lead to a more resilient system (e.g., the use of a water supply system such as Boston) or the result of a crisis that forces managers and stakeholders to adapt (e.g., the Oklahoma drought in the 1990's that lead to use of MESONET in drought and fire planning.)

October 24, 2002
8:30 – 10:00

Eliciting User Needs: Methods from Different Disciplines

Chair: Roger Pulwarty, Climate Diagnostics Center, NOAA/CIRES
Presenters: Jere Gilles, University of Missouri-Columbia, Daniel Suman, University of Miami, Carrie Pomeroy, University of California-Santa Cruz
Rapporteur: Dan Hallstrom, North Carolina State University

Eliciting user needs can help focus the climate science research agenda on improving forecast characteristics that are critical to their routine implementation in decision processes. Social scientists are eliciting user needs by working with actual, and potential, climate forecast users in different regions, sectors, and contexts. Two broad methodological avenues for eliciting information from the user community were discussed in this session. The first is to follow a piece of information until it disappears, or reaches an end-user. The second method is to simply ask users to identify their needs, and the constraints they face in using probabilistic forecast information. All of the presenters used the second method in their own research.

The first theme in the discussion was how researchers can establish their terms of entry, and how the terms of entry may affect user expectations. In the developing countries, terms of entry are often made through non-governmental organizations. Other methods used to gain entry include personal and professional contacts, and contacting local extension or soil conservation agents. In some cases, cooperation with researchers fosters an expectation that policy recommendations will be made, or that the researcher will bring publicity to critical issues and special needs. When expectations are in accordance with the research goal there is no conflict. However, there are instances where criticism of current policies, or the policy-making process, may have been taken personally. In the policy context, there is also a possibility that the political opposition will attempt to use research results that are critical of current policy to further their own goals. In this case, researchers have the responsibility to inform the information providers in advance on the recommendations and results they are going to make public.

A second theme in the discussion was the uses and limitations of various interview techniques. The presenters had more success with semi-structured and open-ended interviews than structured interviews. The more open-ended interviews captured the context within which climate forecasts are used, and the variability among the forecast users. Structured interviews tended to force respondents to think about how they react to climate variability, and to climate forecast information, in ways foreign to their own decision processes. In addition, structured interviews were seen as restricting the conversation to topics that the researcher thinks are important. However, the detail captured in ethnographic surveys can be a handicap in providing information to policy makers. The nature of the policy process in many jurisdictions requires policy makers to

treat everyone equally. Policy makers also rely on more formal, integrative models in their decision processes. As a consequence, policy-makers tend to prefer research results from which they can draw generalities.

The session ended with a discussion on the trend in the social sciences away from the more abstract Bayesian approach to information, toward ethnographic methods. Ethnographic methods have been highly successful in identifying local institutions and perceptions that affect forecast use. However, at some point the research community will have to move toward more integrative modeling. This will require a lot of creative thinking and new methodologies.

Eliciting User Needs: Methods from Different Disciplines

Chair: Carla Roncoli, University of Georgia
Presenters: Aris Georgakakos, Georgia Institute of Technology, Bob O'Connor, National Science Foundation/Pennsylvania State University, David Brookshire, University of New Mexico
Rapporteur: Steve Hu, University of Nebraska

Dr. David Brookshire presented findings from his project "The Use of Climate Information by Water Managers in New Mexico". The focus of the project was to obtain a better understanding of local water resource managers' climate prediction needs and to identify methods to improve their use of forecasts. He interviewed water managers in the Rio Grande Basin, New Mexico and found that local water managers need the "best possible" precipitation and temperature forecasts with lead-times from 7 days to 6 months. Managers would also like to have the climate forecasts reformatted so that they could better understand them.

After this presentation, conference participants questioned when is a forecast "good enough" for water managers to use. Participants also raised the crucial issue that for managers to use forecasts they need to know the linkages of weather conditions and components in the hydrological system of the basin.

Dr. Aris Georgakakos discussed "Climate and Hydrologic Forecast Assessments Using Integrated Decision Support Systems for River Basin Planning and Management". He studied several river basins in the U.S. and within countries in eastern Africa. His decision methods based on climate forecasts were tested in the management of the Folsom Reservoir in California. The test results indicate that it is important to "convert" the uncertainties of climate predictions into uncertainties in hydrological and decision process variables in order to provide a sense of risk that each policy entails, and to adjust management strategy as the forecast unfolds and new forecasts are available. Applying the same concept, Dr. Georgakakos suggested including climate forecasts in making water resource related agreements between states and countries so that the states would have flexible water sharing frameworks.

Dr. Robert O'Connor explained that survey methods can be useful for eliciting user needs and attitudes toward forecasts. He discussed the cognitive basis for how the public perceives the survey experience and how to recognize and interpret potential biases in scientific surveys. He argued that the ability to generate data that can be analyzed through sophisticated multivariate statistical methods is a great advantage of surveys. He noted that survey consumers need to be wary of context effects, i.e., how responses may vary through question sequencing and issue framing. In response to a question of how to address context effects, he suggested "be transparent" in survey results and "explain results in the context of the survey". He further suggested strategies to do a "good survey," including a) hire a professional to do the survey, b) justify every question, and c) be wary of the context effect.

Dr. Carla Roncoli discussed "Salience and Meaning in Knowledge Encounters" from working at three different climate regions in Burkina Faso in Africa. In each region, she used participatory research and in-depth ethnographic interview methods to elicit farmers' climate information needs. She found that a) farmers are most concerned with the onset, duration, and distributions of the summer monsoon rainfall, including intraseasonal monsoon interruption and rainfall intensity, and b) farmers' cognitive models and information priorities affect their interpretation of the seasonal rainfall forecasts issued by local meteorological service agencies. The latter indicates an essential need to add interpretations of forecasts in local cultural context in order to have them correctly used by local farmers.

October 24, 2002
10:15 – 11:45

Integrating Quantitative and Qualitative Approaches with Stakeholder Interactions

Presenters: Kathy Galvin, Colorado State University, and Kathy Miller, National Center for Atmospheric Research.
Moderator and Rapporteur: Greg Carbone, University of South Carolina

Kathy Galvin presented her work on the use of climate forecasts in the livestock sector in arid and semi-arid zones of South Africa. Her project investigates how ranchers are currently dealing with climate variability, how they are using seasonal forecasts, and how forecasts can be enhanced with other tools. The qualitative part of the project includes surveying, formal and informal interviews, and ethnography of those in the livestock sector to understand resources and options that buffer them from interannual climate variability. This information was used to parameterize the ecological model, SAVANNA to specific commercial farms and communal smallholders. SAVANNA was linked to a household economic model designed to determine optimization strategies for each farm under a range of seasonal climate forecasts.

Kathy Miller presented her work on the use of game theory for understanding the complex and dynamic resource system of Pacific salmon. In this example, game theory is used to describe the effects of alternative management strategies given uncertainty and incomplete information about the influence of environmental variables on salmon stocks. The research includes the qualitative approach of structured interviews with participants in the negotiations, fishery scientists, and other stakeholders. The goal of integrating these quantitative and qualitative methods is to understand how shifts in initial conditions might influence negotiations and to discover how the negotiation framework could be structured to ensure both stable cooperative management and an equitable distribution of fishery benefits. In addition, the research evaluates the extent to which the value of improved information depends on whether the international management regime is cooperative or competitive. See Figure 7.

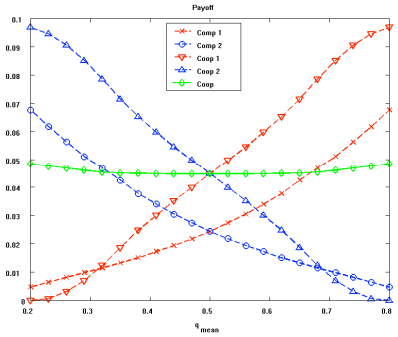
Several themes emerged during the discussion period. Several questions were asked about the degree to which the researchers were implementing their tools, and therefore, influencing decision-making. Miller explained that while the model's computational requirements preclude direct operational use, it has been used to demonstrate the value of cooperation and the effectiveness of side-payments as a bargaining tool. These insights were communicated to the parties involved in the negotiations, and side-payments are now part of the bargaining framework. When competition prevails, the model demonstrates that improved seasonal forecasts of salmon abundance and migratory behavior linked to the PDO signal could lead to over-fishing and resource collapse, while substantial benefits are possible with cooperation.

A discussion ensued about the importance of fieldwork in understanding the South African ranchers' decision making. Galvin pointed out that direct contact with the ranchers was essential for parameterizing models and understanding household goals and management strategies.

Several questions addressed the issue of reporting to the user community. Galvin reported on a second workshop in which her team reported data analysis, showed seasonal climate predictions, and demonstrated a simplified version of the SAVANNA model. She noted that the direct contact with farmers and Department of Agriculture representatives at workshops was particularly useful. Others commented on the importance of interaction among modelers, climate forecasters, and users. This type of interaction allows the users to understand the constraints on forecasts and model output, and allowed the modelers to have a more complete picture of what the users faced. A variety of people described their own efforts to integrate quantitative and qualitative methods in the context of model building. In many cases, a qualitative approach was used to learn more about the system before models were developed.

What the model suggests:

As the average split becomes more uneven, payoffs increase or decrease in the direction of environmental advantage for both competitive and cooperative harvesting. In general, cooperation is most valuable to the environmentally favored player.



What happened:

The 1977 climatic regime shift may caused the "split" to become more favorable, on average, to Canada. Canada:

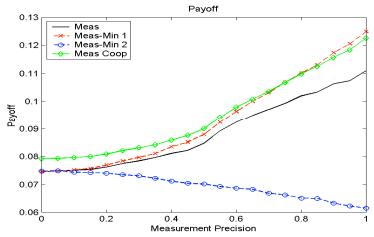
1) **unilaterally increased its harvest share**
2) **successfully negotiated a better deal on division of Fraser sockeye**

What the model suggests:

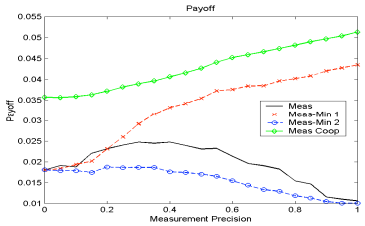
With shift to more depensatory form:

- **Under competition, enhanced information can hurt.**
- **Cooperative surplus increases with depensation & enhanced information**

COMPENSATION



DEPENSATION



What happened:

- **Severe declines in survival rates for southern salmon stocks.**
- **Dramatic increases in northern salmon productivity.**
- **Gradual improvement in scientific understanding of changes ⟶ Enhanced predictability.**
- **Intense efforts to resolve conflict ⟶ 1999 Agreement**

Figure 7. Results from Study on Climate Variations and the International Management of the North American Pacific Salmon Fishery: A Game Theoretic Perspective.

The two presentations served as models for the range of importance of seasonal forecasts. In the South African example, the ENSO signal was strong enough to make seasonal forecasts extremely important to the project. Galvin discussed this in the context of the anomalous teleconnection during the 1997-1998 El Niño, when South Africa did not experience an anticipated drought. For North Pacific salmon, the seasonal forecasts are less critical since the fishery is more closely linked to conditions during the previous two years. Improved observations and links between climate conditions and fishery populations will benefit this resource most.

Vulnerability Mapping

Presenters: Roberto Sanchez-Rodriguez, University of California-Santa Cruz, and Tim Finan, University of Arizona
Moderator and Rapporteur: Jennifer Phillips, Bard College

Both presentations on vulnerability mapping began by presenting a theoretical framework of external and internal effects on vulnerability, referring to the classic structure of a) exposure to hazards, b) coping capacity, and c) resilience or adaptation. The mapping exercise is meant to provide the tools and knowledge to intervene at one or more of these points in order to reduce vulnerability. Although climate affects whole regions, exposure to climate hazards, and coping and resilience mechanisms, are influenced by aspects such as geographic position on the landscape, assets, and political connections. In both presentations, vulnerability mapping allowed for an improvement in the utilization of climate forecast information, but the insertion points differed.

The contexts presented by the two speakers differed in several aspects: Sanchez-Rodriguez presented a case for mapping vulnerability to floods and landslides in Tijuana, Mexico, where exposure is highly conditioned on location in the landscape (either on potentially unstable slopes or in low areas or canyons prone to flooding). Mapping of vulnerable spots allows for better event-driven hazard management as well as long term urban planning. See Figure 8.

In the case of Ceara, Brazil presented by Finan, vulnerability mapping was used as an instrument to insure greater equity of drought relief services. With objective indicators used to identify assistance needs among the population, policy makers could no longer employ patronage to guide relief in the face of climate extremes.

Challenges to implementing a vulnerability mapping approach were discussed by the participants. The following question was posed to Finan: “Given the longstanding importance of access to power and the role of patronage in Brazil, how can a new order of service provision be implemented without a challenge from the ‘old order?’” It was suggested that the emphasis in seasonal climate forecast distribution on equity has had a democratizing effect in Brazil. Local decision makers have to be responsive to the community’s needs now that everyone is aware of forecasts.

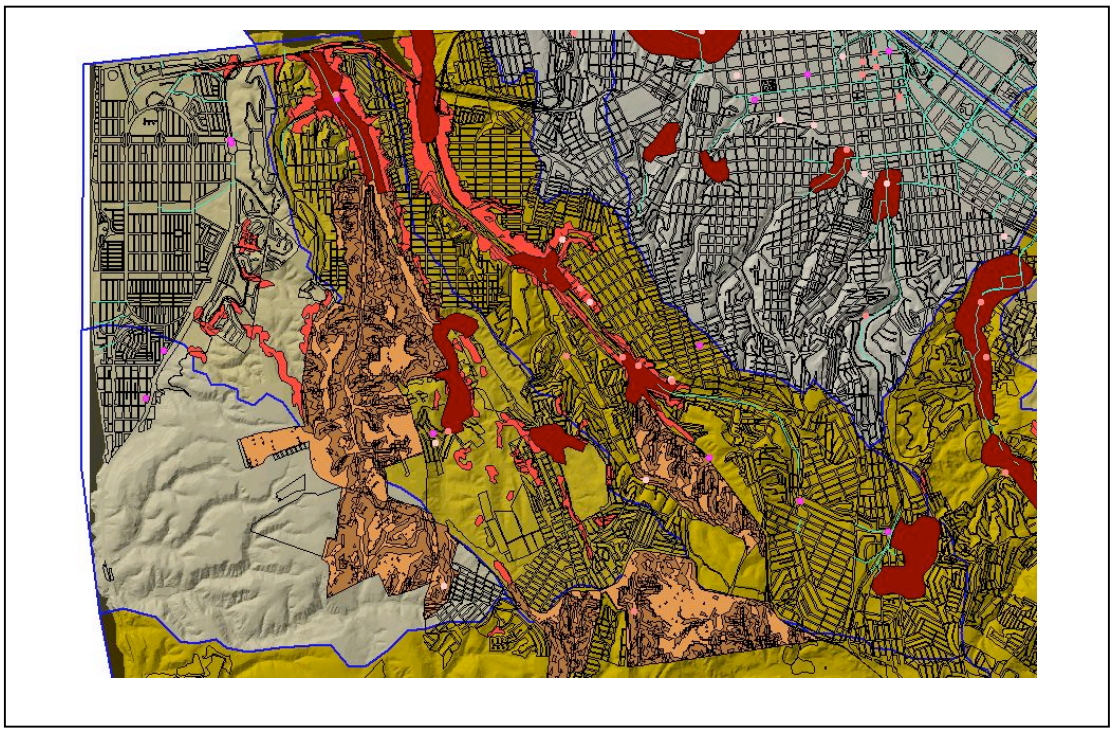


Figure 8. Vulnerability Map for Tijuana Mexico.

A participant raised the point that the third component of vulnerability, adaptive capacity, is the hardest to quantify in a population. Yet, this is an important one if we want to apply lessons from vulnerability to current climate variability to vulnerability to future climate change. It was argued that the distinction between adaptive capacity and resilience is important because resilience to variability now cannot necessarily be translated into adaptive capacity to future changes. The time dimension, also, is not well captured by vulnerability mapping frameworks. We tend to be focused on immediate, short-term hazards. An important thread of this discussion was the idea that we may be able to cope with individual events (or not, in which case the system degrades over time), but the time lag between event-recovery-event sequences is critical since coping capacity or resilience at one time sequence may be inadequate if we speed up the return rate.

In closing the session, it was suggested that vulnerability mapping might be used as a tool for longer term planning on how to build resilience. The group agreed that we may need to look beyond the climate context, and in building resilience to climate extremes, we may consider the larger development/sustainability context.

October 24, 2002
1:30 – 3:30

Information Sources and Tools

Climate Information Project

Presenter: Kelly Sponberg, NOAA/OGP

The Climate Information Project (CIP) is a jointly supported project of the NOAA Office of Global Programs and the USAID Office of Foreign Disaster Assistance.

In the overall effort of the NOAA Office of Global Programs to sponsor focused research on climate and seasonal variations, its predictability, and the interface of such knowledge with human systems, the CIP is an evolving program that addresses issues of information access, dissemination, and use. Global in nature, the CIP works on projects that provide an immediate benefit to the US government and foreign partners, while at the same time learning and gathering lessons that could eventually be applied in the United States.

The CIP produces summaries of Climate-Weather impacts as reported in the media, situation reports, and agency updates. These are archived on the website, made available via e-mail, and generally updated once or twice per week. The impact reports are intended as a condensed summary that is then used to trigger other databases and link to reports and a variety of information. The impacts section of the website also contains links to various impact reporting sites, databases, and related initiatives.

RANET is an effort of several partners to make climate and weather related information more accessible throughout the world. It uses a variety of technologies, such as digital satellite radio, as well as training to accomplish its goal. The CIP is a core participant in this activity. From the CIP you can learn more about RANET. View its broadcasts as mirrored online, and participate in online discussions about the project.

More information about the Climate Information Project can be found at www.cip.ogp.noaa.gov/.

The HERO Collaboratory

Presenter: Brent Yarnal, Pennsylvania State University

Understanding global environmental change in local places cannot happen in isolation. To build a picture of the local causes and consequences of global change, scientists who study and monitor this problem must share data, methods, and ideas. The World Wide Web makes it possible for scientists to work collaboratively without leaving their computers. Researchers working on the NSF and NOAA-OGP supported HERO

infrastructure development project are developing a collaboratory to foster remote collaboration among scientists studying global change in far-flung local places. Collaboratories use the interconnectivity of the Web to link scientists in near-real time, if not real time. Collaboratories go beyond e-mail and instant messengers to include such novel ideas as Web-based videoconferences, electronic Delphi tools, shared notebooks and databases, and interactive maps and graphs.

More information about the HERO project can be found at: http://hero.geog.psu.edu/projectDescription.htm.

Decision Making Software

Presenter: Jennifer Phillips, Bard College

The collaborative effort presented, "Responding to Climate Forecasts – Using Scenarios in the Planning Process", is a web-based learning activity designed to build skills in utilizing probabilistic information in decision making through the use of a scenario-building activity. The activity was developed as a collaboration between the International Research Institute for Climate Prediction (IRI), the Columbia New Media Teaching and Learning Center, and Columbia University faculty. The site presents both the theoretical basis for steps in a scenario-building exercise and a series of case studies in which the steps are exemplified in a variety of decision-making contexts. Links to tutorials and instructions for accessing data and other ancillary information are incorporated into the site such that users can utilize the framework to construct their own decision scenarios. The site can be viewed by individuals online outside of an organized educational setting, or used as part of a workshop or classroom learning activity. Our first test of this material took place in July 2002 as part of a three-week training course conducted at the IRI. We reported here the results of formal and informal evaluations that were gathered during that time, and plans for future development.

The website is: http://www.ccnmtl.columbia.edu/projects/iri/responding/index.html

Team members included: IRI team: Jennifer Phillips (now at Bard College), Tahl Kestin, Brad Lyon; CCNMTL team: Cynthia Lawson, Kristen Solulski, Bernie Kluger; Other University of Columbia contributors: Dave Krantz, Galith Marcus, Mike Bell

Mapping the Climate Applications Landscape

Presenter: Tahl Kestin, IRI

Significant advances made in seasonal climate forecasting since the 1980s have spurred a number of activities related to the application of such information for societal benefit. Applications research and projects, although initially supply driven by members of the climate forecasting community, have over time brought a small but growing group of

researchers from other disciplines into their fold. It may be argued that there currently exist loose networks of researchers, practitioners, and users of climate forecast information who interact occasionally through meetings, projects, and a shared body of literature. However, these networks are often based on disciplinary or regional interests, with little interaction between them. To date there have been few systematic attempts to form a global picture of this 'community' of individuals and institutions, and the nature of their research outputs. Such a picture is necessary in order to improve the cohesion of the community and therefore to better steer its future direction. In this project we aim to review and synthesize applications activities to date through the development of a database, construction of a typology, and a quantitative and qualitative analysis of activities.

Database
A considerable effort and a variety of search strategies have gone into collecting and distilling information on publications (journal articles, books, reports, and conference abstracts) on climate applications and related topics. Of the 1500 publications currently listed in the database, approximately 400 are directly related to forecast applications; of these, approximately 200 are journal articles – representing a 'critical mass' of work on applications. The database is currently being designed to be searchable and updateable online, as a shared and ongoing resource for the community and other interested parties.

Typology
In close association with building the applications database, we have been developing a typology to identify and define the major themes of applications activities and to organize them within the broader framework of climate–society interactions. In addition to the typology based on activity types, we also developed typologies for region and sector. Each entry in the database was categorized according to these three typologies.

Quantitative and qualitative analysis
Based on the database and the typology, we have been analyzing various aspects of applications efforts to date, including activities undertaken, sectoral and regional focus, temporal trends in activities, and estimates of community size. We also plan to undertake a comprehensive literature review to identify common themes in the aims and conclusions of applications studies.

Team members included: Shardul Agrawala, Kenny Broad, and Tahl Kestin
Project year: 2002

Datasets available at the International Research Institute for Climate Prediction (IRI)

Presenter: Anji Seth, IRI

The mission of the IRI is to enhance society's capability to understand, anticipate and manage the impacts of seasonal climate fluctuations, in order to improve human welfare

and the environment, especially in developing countries. This mission is to be conducted through strategic and applied research, education and capacity building, and provision of forecast and information products, with an emphasis on practical and verifiable utility and partnerships.

The IRI website focuses on education and provision of monitoring and forecast information products including the following:

- IRI 'Climate Information Digest' is a monthly summary of recent climate events, impacts, and seasonal forecasts: http://iri.columbia.edu/climate/cid/

- 'Highlights' relates past rainfall and temperature with likely future conditions, with a quick look to regional impacts from a global perspective. Derived largely from IRI's Climate Information Digest, this monthly product is also available for limited distribution as a printed flier. http://iri.columbia.edu/climate/highlight/

- The latest ENSO information can be found in the ENSO Quicklook at http://iri.columbia.edu/climate/ENSO/currentinfo/QuickLook.html and more detail in the ENSO Update at http://iri.columbia.edu/climate/ENSO/currentinfo/update.html.

- 'ENSO Web' is a comprehensive site with background and current information on the El Niño-Southern Oscillation (ENSO), El Niño and La Niña, including a section on ENSO and society which addresses impacts and responses at http://iri.columbia.edu/climate/ENSO/

- IRI 'Map Rooms' offer many detailed analyses of current global and regional climate, as well as historical data. Many maps are linked directly to the IRI Data Library - for quick access to the data being viewed just click on the map. You will then be able to change dates, views, or even download the data. The map rooms at http://iridl.ldeo.columbia.edu/maproom/ are divided into 3 sections:
    - Global: current and past observations of the global physical climate including climatologies;
    - Regional: current and past observations of regional physical climate including climatologies;
    - ENSO: analyses for monitoring the current and past state of the El Nino Southern Oscillation (ENSO)

- IRI/LDEO Climate 'Data Library' http://iridl.ldeo.columbia.edu/ contains a wide variety of earth science data, primarily oceanographic and atmospheric datasets. The Introduction to Climate Data picks out a few of the most generally interesting datasets, and the Data Library Overview shows some of the many ways the data can be accessed and manipulated. There are some step-by-step examples, as well as many answered questions.

October 24, 2002
7:00 – 9:30 p.m.

What's Hot & What's Important

Co-Chairs and Rapporteurs: Kris Wernstedt, Resources for the Future and Bill Easterling, Pennsylvania State University

A variety of ideas were vetted in the 75-minute après-dinner discussion about settled, emerging, and burning concerns in Human Dimensions. The evening's discussion leaders started off with several of their own favorite topics—continuing difficulties in accommodating uncertainty in decision making, risks of forecast failures, ethical and legal aspects of forecasting, the distributional effects of asymmetric forecast use among advantaged and disadvantaged populations, and the HD community's continuing struggle to define the policy audience for its work. All of these plus plenty others garnered attention over the course of the evening. Not surprisingly, no single thread was pursued for more than five or ten minutes at a go, since the room housed an abundance of bright people both with relevant experiences and insights and the spirit to share them. However, five strands of the discussion stand out from the others as being particularly animated.

First, a number of investigators noted with approval that the HD community has carved out a niche for itself—one that has welcomed research across a number of disciplines, scales, stakeholder groups, and methodologies—and helped promote a cultural change among IPCC, National Weather Service, World Meteorological Organization, *etc*. regarding forecast use. HDers have been particularly effective in illuminating adaptability to climate variability and thus have the opportunity to apply their comparative advantage in adaptive behavior in the short-term context to questions of adaptation to longer-term climate change. Several investigators suggested that the HD program should in fact move toward formalizing this by focusing the program explicitly on adaptation to climate change. However, others warned that it must not lose its hook of climate variability if it moves to broader notions of vulnerability.

Second, the HD program has enjoyed great successes by supporting a balance of modeling efforts and ethnographic case studies. The investment in both is a hallmark strength of the HD program and demonstrates a commitment to a diversity of fundamental and applied research. However, many discussants believe it is now time to begin to distill generalizations from the case studies and move them into the modeling domain. The HD program is already starting down this track with its integrative review studies. However, it is important that the HD program begin to support comparative case studies that (potentially) yield results that can be integrated into formal qualitative or quantitative models.

Third, notwithstanding HD's success in carving out a niche—and in creating a collection of investigators with a sense of solidarity—the community faces obstacles to growth. Resources to support HD work are likely to remain very limited relative to the need and

to other kinds of climate related work, and HDers have not yet succeeded in moving HD research to a higher priority among those who allocate funding. Related and more contentiously, it is not clear that HD work has fully demonstrated policy relevance. This was an arguable point, with many investigators pointing out their own and others extensive work with end users, but others noting the limited impact and work with higher-level (*i.e.*, less operational) decision making entities, NGOs, and the business community to promote more pervasive institutional change. In addition, several commented that promoting policy relevance is complicated by HD's location in a mission-oriented agency that has tried to balance research and practice.

Fourth, the HD community needs to take advantage of possible collaborative opportunities with the Federal Emergency Management Agency, U.S. Agency for International Development, energy sector, natural hazards community, state governments, and other possible partners. In addition to attracting support, such collaborations and partnerships may help to promote relevance at both the operational and policy level. In the same vein, several investigators supported the idea of establishing an HD advisory board—perhaps with private sector involvement—to help the program continue to be relevant and to support high priority areas.

Finally and more prospectively, the evening's discussion made it clear that climate sensitivity is but one of numerous stresses that society faces and forecasts but one type of information to use, and that ultimately society has only a limited capacity to respond to climate variability and change. These features should shape future HD research directions. Including other stresses—social, economic, political, and environmental—in HD work is essential if they shape climate sensitivity, and if HD is to continue to remain relevant to the needs and priorities of end users. The pressure to broaden the contexts of stress and information in which HD works, however, must be weighed against the risk of dissipating energies and resources and thereby weakening HD's message. Discussants suggested that synthesizing lessons learned from HD case studies, examining the limitations and constraints of technology transfer more generally, and developing longer-term collaborative projects with decision makers constitute three promising directions the HD program could explore.

October 25, 2002
8:00 – 9:30

The Need for Greater Integration of Human Factors into Research on Climate and Health

Presenter: Juli Trtanj

Juli Trtanj presented an overview of the NOAA Climate Variability and Health program and discussed the need to integrate Human Dimensions researchers and their social

science methods into research on climate variability and its implications for human health.

The NOAA Climate Variability and Health Program (CVH) is designed to take a problem-oriented approach to the use of climate and environmental information for social benefit. The goal of the program is to provide scientifically sound, socially relevant and technically useable climate and environmental information for the public health community. Toward that end, the CVH program seeks to identify and address gaps in knowledge and institutional structures, foster greater coordination among agency and private sector partners, and build a strong climate and health community.

The CVH program is comprised of four main components: Research, Application, Capacity Building and Training, and Community Building. Driven by the need to develop a solid scientific understanding of the influence of climate and environmental factors on public health, the Program supports and manages the Joint Announcement on Climate Variability and Human Health. This research grant announcement is a cooperative effort among NOAA, the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and EPRI (formerly known as the Electric Power Research Institute). In addition, the CVH Program works closely with the other NOAA CSI programs to ensure research questions are derived from, and results feed back to, decision-makers attempting to use climate information operationally. In collaboration with other agencies, academia, international institutions, and regional partners, the CVH program supports training and other activities that build capacity to use climate information for public health purposes. The program also focuses on building a robust climate and health community, helping to bring together various communities and disciplines to foster an iterative definition of the problem and collective development of approaches and solutions.

More information about NOAA's Climate and Health program can be found at www.ogp.noaa.gov/mpe/csi/appdev/health/index.htm.

NOAA Post-Doc Program

Emma Archer and Colin Polsky, both alumni of the NOAA/OGP Postdoctoral Program in Climate and Global Change, enthusiastically endorsed the program and reported that it was a good experience for them. UCAR manages this NOAA-sponsored program, which pairs recently graduated post-doctorates with host scientists at U.S. institutions to work in an area of mutual interest. Each year, there is a competition for entry into the program. In 2003, the applications were due in January.

The objective of this program is to help create the next generation of researchers needed for climate studies. It endeavors to attract recent PhDs in sciences that address studies of relevance to the NOAA Climate and Global Change Program (C&GC). The Program focuses on observing, understanding, modeling, and predicting the climate system on

seasonal-to-centennial time scales and assessing the regionally specific socioeconomic consequences of climate variability.

Applications are solicited from qualified postdoctoral candidates. Preference is given to those who have held a PhD for no more than five years. Awardees must change institutions in the absence of compelling circumstances. A clear indication of the scientific areas to be pursued and goals is particularly important. A steering committee, broadly representing the skills and interests covered by the NOAA C&GC program, selects the fellows and recommends appointments with U.S. agencies and institutions. For additional information, please see: http://www.vsp.ucar.edu/VSPtoc.html

Funding Opportunities with the National Science Foundation

Presenter: Bob O'Connor

Climate Change Research Initiative: Decision Making Under Uncertainty

The budget proposed by the Administration and approved by both houses of Congress has $5 million in funding to support research related to decision making under uncertainty for climate change. If obligated, these funds would probably be used to establish three to five centers. Each center would be supported at $1.0 to $1.5 million annually for up to five years. Support will probably also be provided for workshops, symposia, high-risk exploratory efforts and supplements to current awards. Because a final budget has not yet been approved by Congress, the formal announcement will probably not appear until March or even later.

The basic idea is to fund research on whether and how to adapt to and/or mitigate the possible consequences of climate change and variability, given the information currently available. This research would complement the large body of research on climate change that tries to reduce uncertainty by getting more information, developing better analytic models, etc.

While the focus is on decision making related to climate change, it is hoped that research funded by this initiative will also:

a. advance our understanding of basic questions in decision science (e.g., intertemporal tradeoffs, prescriptive issues in decision making under uncertainty, risk perception and communication) and

b. provide insights and tools that can fruitfully be applied to other important societal decisions involving uncertainty.

Note: since the time of the NOAA Human Dimensions PI meeting, the call for proposals under this initiative has been published. Information can be found

under "Human and Social Dynamics: Special Competition for FY 2003" on NSF's web site.

October 25, 2002
10:15 – 11:00

Future Directions: Following is an overall summary of small group discussions on next steps for the NOAA/OGP/HDGCR program.

The PIs made a number of recommendations for future directions for the program. Among their recommendations were to:

- Improve our understanding of climate variability in a societal context beyond forecasts. This would include analyzing how society copes with year-to-year variability, measuring adaptive capacity (specifically resilience and vulnerability), understanding the ethical and equity dimensions of disseminating scientific information, and developing a suite of response options and/or tools.

- Focus first on how people manage resources; avoid pushing seasonal forecasts. Using climate variability as a way of studying resource management could provide a better understanding of the broader issues of communicating information, decision making under uncertainty, sustainable use of resources, and adaptation to climate change (e.g., How do institutions respond to stresses in the system (i.e., growth demands) in the context of climate variability and change?).

- Include studies on the linkages to disaster mitigation (e.g., emergency planning at local levels).

- Forge better linkages between local and regional scales.

- Incorporate attention to local languages and cultures in the preparation of forecasts and other climate products. A good deal of misunderstanding of forecasts comes from poor translations from English and other major language groups into local languages.

APPENDIX A
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APPENDIX B
Conference Participants and the Sector of their NOAA Research

	SECTOR							
	Ag/Livestock	Energy	Fisheries	Health	Nat.Resrcs	Urban	Water	Other
1 Adams, Richard			X					
2 Archer, Emma	X							
3 Avery, Susan								
4 Basher, Reed								
5 Beller-Simms, Nancy								
6 Brookshire, David							X	
7 Buizer, Jim								
8 Carbone, Greg							X	
9 Carpenter, Theresa							X	
10 Clark, Candyce								
11 Dow, Kirsten							X	
12 Easterling, Bill								
13 Finan, Tim	X							
14 Galvin, Kathy	X							
15 Georgakokos, Aris	X	X					X	
16 Gilles, Jere	X							
17 Hallstrom, Daniel	X							
18 Hamnett, Mike			X	X				
19 Hu, Steve	X							
20 Iglesias, Ana	X							
21 Kestin, Tahl								X
22 Kirshen, Paul	X							
23 Lach, Denise							X	
24 Lemos, Maria Carmen	X							
25 Lewis, Nancy				X				
26 Meo, Mark					X			
27 Micko, Aurelia								
28 Miller, Kathleen			X					
29 Miller, Roberta						X		
30 Mjelde, Jim	X							
31 Neill, Juniper								
32 Nierenberg, Claudia								
33 O'Connor, Bob							X	
34 Orlove, Ben	X		X		X			
35 Patt, Tony	X							
36 Phillips, Jennifer	X							
37 Polsky, Colin					X			X
38 Pomeroy, Caroline	X		X					
39 Pulwarty, Roger							X	
40 Quinn, Loretta								
41 Rayner, Steve							X	
42 Roncoli, Carla	X							
43 Sanchez, Roberto						X		
44 Scott, Michael	X							
45 Seth, Angie								
46 Simpson, Caitlin								
47 Slaughter, Richard	X	X	X				X	
48 Sponberg, Kelly								
49 Suman, Dan			X					
50 Thompson, Bree								
51 Trtanj, Juli								
52 Valdivia, Corinne	X							
53 Vaughn, Lisa								
54 Weiner, John							X	
55 Wernstedt, Kris							X	
56 Yaka, Pascal	X							
57 Yarnal, Brent							X	

Appendix C
Conference Participants, their Affiliations, and the Location of their NOAA Research

	AFFILIATION			LOCATION					
	PI	OGP	Other	Africa	Arctic	Mediterranean	Latin Am.	Pacific	US
1 Adams, Richard	1								X
2 Archer, Emma	1			X					
3 Avery, Susan			1						
4 Basher, Reed			1						
5 Beller-Simms, Nancy		1							
6 Brookshire, David	1								X
7 Buizer, Jim		1							
8 Carbone, Greg	1								X
9 Carpenter, Theresa	1						X		X
10 Clark, Candyce		1							
11 Dow, Kirsten	1								X
12 Easterling, Bill			1						
13 Finan, Tim	1						X		
14 Galvin, Kathy	1			X					
15 Georgakokos, Aris	1			X		X	X		X
16 Gilles, Jere	1						X		
17 Hallstrom, Daniel	1								X
18 Hamnett, Mike	1							X	
19 Hu, Steve	1								X
20 Iglesias, Ana	1			X		X			
21 Kestin, Tahl	1								
22 Kirshen, Paul	1			X					
23 Lach, Denise	1								
24 Lemos, Maria Carmen	1						X		
25 Lewis, Nancy	1							X	
26 Meo, Mark	1								X
27 Micko, Aurelia		1							
28 Miller, Kathleen	1								X
29 Miller, Roberta	1								X
30 Mjelde, Jim	1								X
31 Neill, Juniper		1							
32 Nierenberg, Claudia		1							
33 O'Connor, Bob	1								X
34 Orlove, Ben	1			X			X		
35 Patt, Tony	1			X					
36 Phillips, Jennifer	1			X					
37 Polsky, Colin	1				X				X
38 Pomeroy, Caroline	1								X
39 Pulwarty, Roger	1								X
40 Quinn, Loretta			1						
41 Rayner, Steve	1								
42 Roncoli, Carla	1			X					
43 Sanchez, Roberto	1						X		
44 Scott, Michael	1								X
45 Seth, Angie			1						
46 Simpson, Caitlin		1							
47 Slaughter, Richard	1								X
48 Sponberg, Kelly		1							
49 Suman, Dan	1						X		
50 Thompson, Bree		1							
51 Trtanj, Juli		1							
52 Valdivia, Corinne	1						X		
53 Vaughn, Lisa		1							
54 Weiner, John	1								X
55 Wernstedt, Kris	1								X
56 Yaka Pascal	1			X					
57 Yarnal, Brent	1								X
	41	11	5						

APPENDIX D
List of Projects Funded 1995–2002

PIs and Institutions	Project Title	FY Funded
Richard M. Adams Oregon State Univ.	The Value of Improved ENSO Forecasts: A Preliminary Assessment of Effects on Fisheries in the Pacific Northwest	1995
Paul Epstein, Harvard School of Public Health	Human Health and Economic Dimensions of Climate Fluctuations	1995
Michael Glantz, NCAR/ESIG	Assessing the Use and Value of ENSO Information for Food Security in Southern Africa	1995
Gordon M. Kaufman/ Henry D. Jacoby MIT	Uncertainty Analysis in an Integrated Assessment of Climate Change	1995
Robert W. Knecht/Biliana Cicin-Sain, Graduate College of Marine Studies, Univ. of DE	Coastal Margin Governance and Climate Change: Effective Responses Through More Adaptive and Integrated Management	1995
Alan L. Kolata (Univ. of Chicago) and Michael W. Binford (Harvard)	Human-Climate Interactions in the Lake Titicaca Basin of Bolivia	1995
R. Lempert, S. Bankes (RAND), M. Schlesinger (U. of IL), S. Popper (RAND)	The Impacts of Climate Fluctuations on Near-Term Policy Choices and the Value of Information: An Adaptive Decision-Making Framework	1995
Edward Miles, Univ. of Washington	Integrated Assessment of the Dynamics of Climate Change, Climate Change Impacts and Policy Response Strategies for the Pacific Northwest: A Research Design	1995
James Mjelde, Texas A&M Univ.	Assessing the Economic Impacts of Improved Climate Forecasts at the National Level	1995
Daniel Suman, Rosenstiel School of Marine & Atmospheric Science	Adaptations Fishing Sectors to the Impacts of El Niño Climate Variations: The Case of Chile	1995
Gary Yohe, Wesleyan University	Greenhouse Gas Emissions, Economic Costs of Physical Effects and Adaptation-The Case of Sea Level Rise	1995
Allan Auclair Science and Policy Associates, Inc	An Integrated Assessment of the Social and Economic Effects of Extreme Climatic Fluctuations on Forests in the Northeast United States.	1996

Paul Epstein, Harvard School of Public Health	Human Health & Economics Dimensions of Climate Fluctuations	1996
Robert Mendelsohn Yale Univ.	A Ricardian Estimate of the Agricultural Value of Improved ENSO Weather Forecasting	1996
James Mjelde, TX A&M Univ.	Effects of Seasonal Climate Forecasts on the Competitiveness in the Grain Market	1996
Norm Rosenberg, Pacific Northwest Laboratories	Sensitivities of North American Agriculture to ENSO-based Climate Scenarios and Their Socio-Economic Consequences: Modeling in an Integrated Assessment Framework	1996
Dr. Michael Hamnett Pacific Basin Dvlpmnt Council	Impacts of Environmental Variability on Tuna Fisheries in the Pacific Islands	1997
Dr. Paul Kirshen Tufts Univ.	A Case Study of Burkina Faso; Opportunities and Constraints to Using Seasonal Precipitation Forecasting to Improve Rainfed Food Production systems at the Village Level in the Sahel-Sudano Region	1997
Dr. Maria Carmen Lemos, Univ. of AZ	Social and Policy Implications of Seasonal Forecasting: A Case Study of Ceara, Northeast Brazil	1997
Dr. Nancy Lewis Univ. of HI/Manoa	The Relationship Between Water-Borne and Water-Related Diseases and ENSO Linked Events in Pacific Islands	1997
Dr. Mark Meo Univ. of OK	Climate Prediction, Information and Policy Response: A Retrospective Assessment of Drought Management in Oklahoma	1997
Daniel Sumner Univ. of CA, Davis	Improved Climate Forecasts and Grain Supply in East Asia: Implications for International Markets	1997
Roger Pulwarty Univ. of CO, Boulder	The Role of Climate Variability and Forecasts in Adaptive Management of the Colorado River: Balancing the Resources Objectives of the Lower and Upper Basin at Glen Canyon Dam	1997
K.A. Galvin, J. Ellis (CO State Univ.) and C.H. Vogel (Univ. of Witwatersrand, South Africa)	Responses to Climate Variability and Utility of Climate Forecast Information for the Livestock Sector in the Arid and Semi-Arid Zone, South Africa	1998
Kathleen A. Miller (National Center for Atmospheric Research), Robert McKelvey (Univ. of MT)	Climatic Variations and the International Management of the North American Pacific Salmon Fishery: A Game Theoretic Perspective	1998

Steve Rayner (Battelle/PNNL), Denise Lach (OR State Univ.), Mark Houck (George Mason Univ.), Helen Ingram (Univ. of CA-Irvine)	The Use of Climate Forecast Information in Decision-making Processes	1998
Michael Scott (Battelle/PNNL),	Early Warning of ENSO Events For Regional Agriculture	1998
Dan Sumner Univ. of CA-Davis	Climate Forecasts and Pacific Rim Grain Markets	1998
Martin Visbeck Lamont-Doherty, Columbia Univ.	Impacts of the North Atlantic Oscillation - Using Economic Data to Quantify Human Sensitivity to Natural Climate Variability	1998
Daniel S. Wilks, Arthur T. DeGaetano, Timothy D. Mount Cornell Univ.	Optimal Use of the Climate Prediction Center's Long-Lead Outlooks: Improved Interpretability and Decision-Analytic Case Studies	1998
Charles Howe, John Wiener, & Terrence Fulp (Univ. of CO), David Brookshire & Dr. Chris Nunn-Garcia (Univ. of NM), Daniel McCool (Univ. of UT), & Randall Dole (CDC/NOAA, Boulder, CO.)	Exploratory Assessment of the Potential for Improved Water Management by Increased Use of Climate Information in Three Western States	1999
Ronnie D. Lipschutz & Caroline Pomeroy Univ. of CA, Santa Cruz	CA Fishery, Farm and Environmentally Vulnerable Community Responses to the 1997-98 ENSO Event	1999
Sarah Meltzoff, Nelson Ehrhardt and Daniel Suman (Rosenstiel School of Marine & Atmospheric Science, Univ. of Miami) & Kenny Broad (Lamont-Doherty, Columbia Univ.)	Effects of El Niño Events on Peruvian Social Economies & Legal Systems	1999
James W. Mjelde, James W. Richardson, J. Richard Conner, and Jerry W. Stuth (Texas A&M Univ.)	Economic Viability of Rangeland Based Ranching Enterprises	1999
Daniel A. Sumner, Daniel Hallstrom, Hyunok Lee, & Brian Weare, Univ. of CA, Davis	Improved Climate Forecasts and Pacific Rim Grain Supply and Markets:	1999
Kris Wernstedt & Robert Hersh Resources for the Future, Washington, DC	Amplifying the Policy Signal: La Niña Forecasts and Flood Management in the Pacific Northwest	1999

Corinne Valdivia & Jere Gilles (Univ. of MO-Columbia), Roberto Quiroz (Intntl Potato Cntr), Christian Jetté (UN Dvlpmnt Prog.-Bolivia), Fundación PROINPA - Bolivia (Foundation for promotion & rsrch of Andean products), & CIRNMA - Peru	Climate Variability and Household Welfare in the Andes: Farmer Adaptation and Use of Weather Forecasts in Decision Making	1999
Brent Yarnal (PA State Univ.), Kirstin Dow (Univ. of SC), Richard Bord & Robert O'Connor (PA State Univ.), & Gregory Carbone & Susan Cutter (Univ. of SC)	Decision-Making and Long-Lead Climate Forecasts: A Case Study in Community Water System Management	1999
Tim Finan , Maria Carmen Lemos , Roger Fox (Univ. of AZ), & Alejandro Leon (Universidad de Chile), Don Nelson (Univ. of AZ)	Use and Usefulness: a Comparative Study of Seasonal Climate Forecasting - Systems in Drought-affected Regions of Latin America	2000
Emilio Moran, Indiana Univ.	Human Strategies for Coping with ENSO and the Growing Flammability of Forest in Amazônia	2000
Jennifer Phillips, IRI, Columbia Univ., Ben Orlove, Lamont Doherty, Columbia Univ.	Improving Climate Forecast Communications For Farm Management In Zimbabwe	2000
Roberto Sanchez-Rodriguez, Univ. of CA, Santa Cruz, Lina Ojeda & Nora Bringas, El Colegio de la Frontera Norte, Cecilia Conde, UNAM	Reducing the Negative Consequences of Climate Variability through the use of Forecasts and Vulnerability Analysis in Cities: The Case of Tijuana, Mexico	2000
Hu, Steven, Lynne, Gary D., Waltman, Wm J, Wilhite, Donald A., Hubbard, Kenneth G., and Hayes, Michael J., Univ. of Nebraska-Lincoln	Engaging Agricultural Communities in the Great Plains of the United States with the Applications and Developments of Climate Predictions and Information	2002
Kirshen, Paul and Jost, Christine, Tufts; Ingram, Keith, Roncoli, M. Carli, Hoogenboom, Gerrit, University of Georgia	Evaluate Communication Modalities, Intermediary Effectiveness and Appropriate Levels of Intervention in the Provision of Climate Forecasts in the Sahel-Sudan: Climate Forecasting for Agricultural Resources (CFAR) – Phase 2	2002

Miller, Roberta, Columbia University, Rosenzweig, Cynthia, Lenhardt, W. Christopher, and Downs, Robert	Climate Change Information for Urban Policy and Decision Making	2002
Patt, Anthony, Boston University	Testing the Ability of Subsistence Farmers to Use Seasonal Climate Forecasts: A Participatory Approach in Zimbabwe	2002
Pielke, Jr., Roger, Univ. of Col./CIRES, Sarewitz, Daniel, Columbia, Conant, Richard, Colorado State	Co-funded with Carbon Cycle Program: Understanding and Enhancing Linkages between Decision Making and Carbon Cycle Research	2002
Iglesias, Ana (Columbia), Ward, Neil (IRI), Rosenzweig (NASA/Goddard), Cullen, Heidi (NCAR)	Utility of Climate Information in Drought management in the Mediterranean Region: A Comparative Study of Actual and Improved Communication Methods	2003

Acronym List

CCRI	Climate Change Research Initiative
CCSP	Climate Change Science Program
CSI	Climate and Societal Interactions
ENSO	El Niño Southern Oscillation
HD	Human Dimensions
HDGCR	Human Dimensions of Global Change Research
HERO	Human-Environment Regional Observatory
IRI	International Research Institute for climate prediction
OGP	Office of Global Programs
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
PEAC	Pacific ENSO Applications Center